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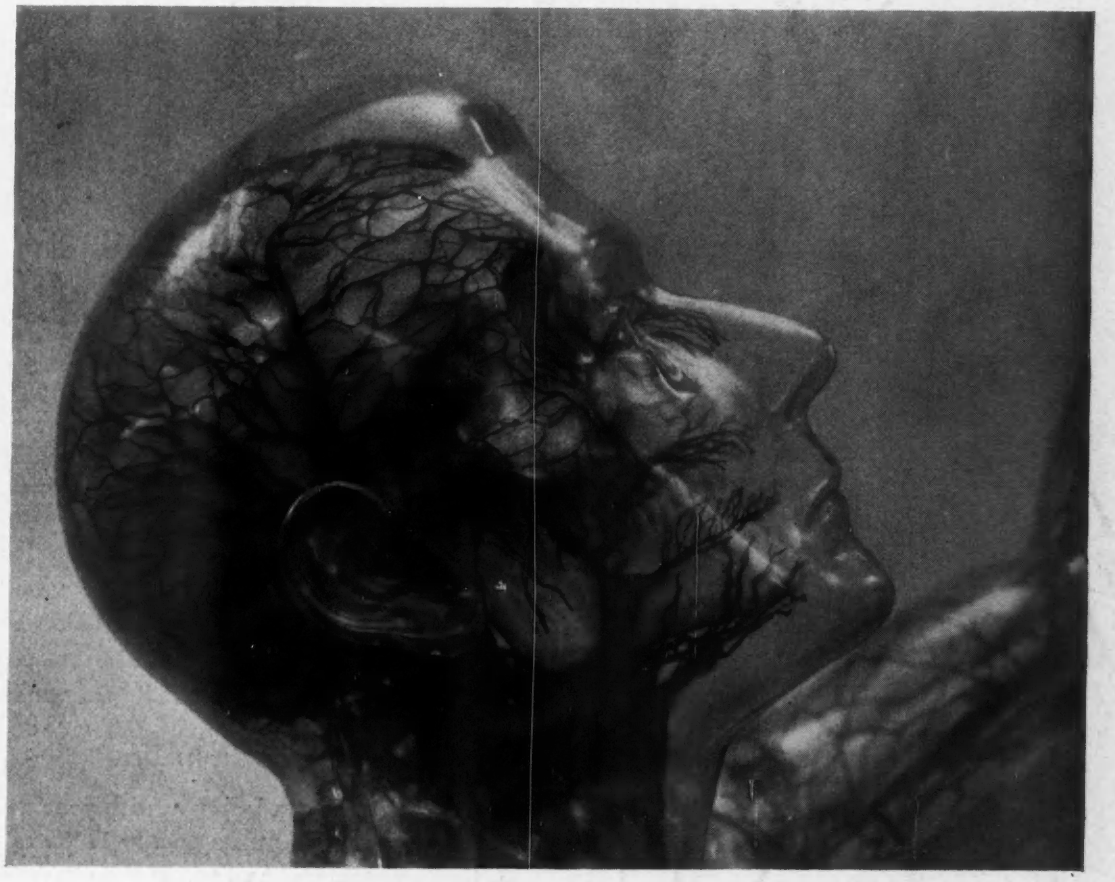

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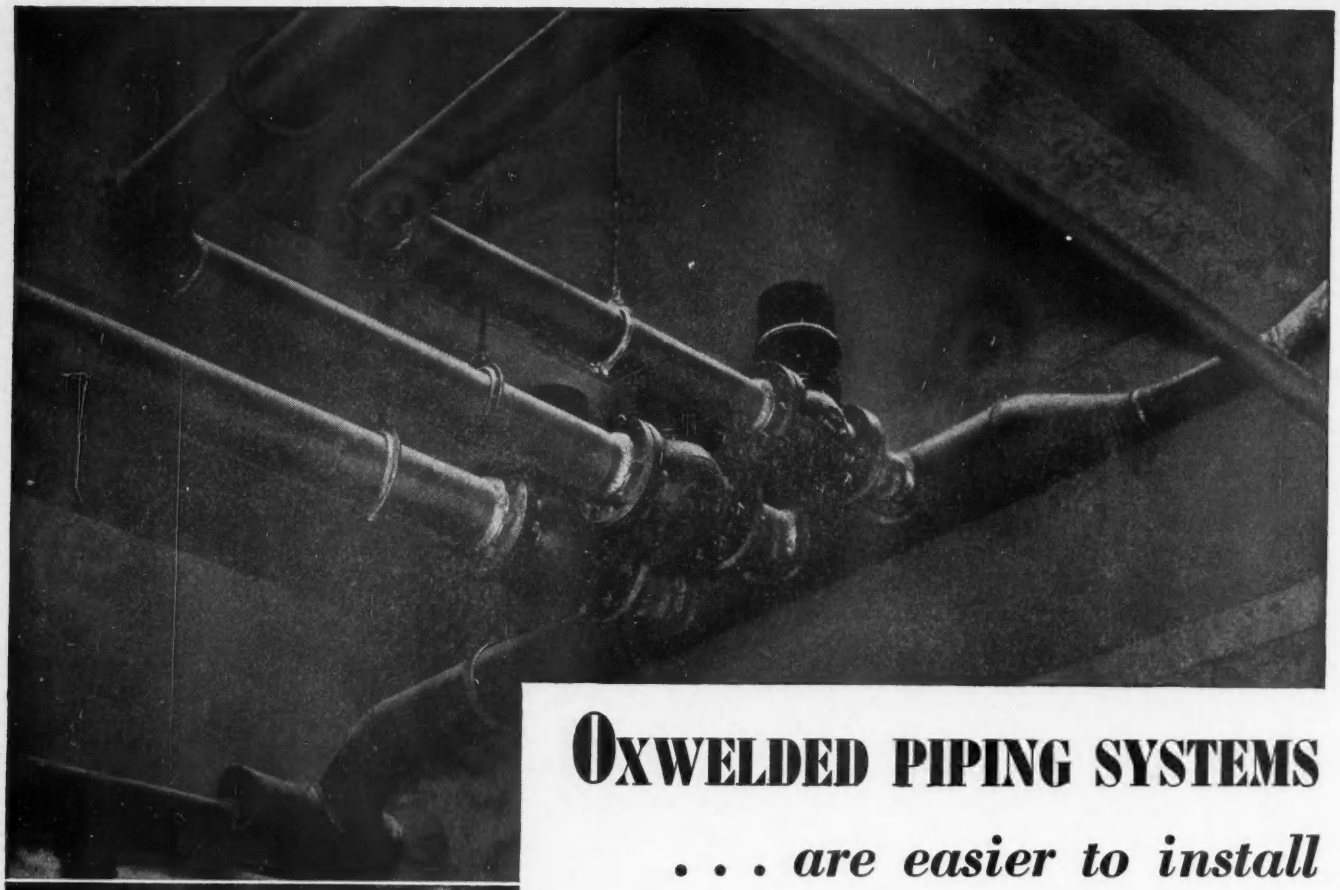

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OUR AUTHORS

DR. AVERY A. MORTON, author of *The Relationship of Cancer and Organic Chemicals*, was graduated from Catner College, Nebraska in 1913, and received his Ph.D. in Organic Chemistry from the Massachusetts Institute of Technology in 1924. He is a member of the American Chemical Society. Before Dr. Morton started to work on carcinoma, he did some research on the purification of rosin. At present he is working on the relationship of certain organic chemicals to cancer. He has published one short paper on the subject in *Science* and a report on the progress of the research now going on will be published in the *American Journal of Cancer*.

PROFESSOR GEORGE OWEN, '94, who wrote the article "*Frostbite*" *Dingies*, has made many valuable contributions to the art of yachting. He, above all others, is responsible for the development, under the so-called universal rule, of the Class R and Class P yachts. He was the designer of the *Defiance* an aspirant to become a cup defender. He designed the *Rodney* and in her won the first ocean race from New York to Marblehead. Under the stimulus of this race the annual ocean races to Bermuda have developed.

F. ALEXANDER MAGOUN, '18, the writer of *The Ruts of Stagnation*, was once an instructor in Naval Architecture, and is now Associate Professor of Humanics at Technology. He has written on such diverse subjects as "The Frigate *Constitution* and other Historic Ships"; "Sky High—The Story of Aviation" (with Eric Hodgins, '22); and "Problems in Human Engineering". He has also written a number of papers on various subjects, and has spoken before many societies.

ARTHUR COBB HARDY, Professor of Optics and Photography at Technology, author of our article *A New Deal for Color*, occupies an eminent position in this branch of Physics. He has a consulting practice in the field of optics and photography, and is the author of numerous scientific papers on these subjects. Among his recent accomplishments is the invention of an automatic color analyser which is the most efficient apparatus of its kind in existence. He received his M.S. degree from the University of California in 1919. He was appointed Assistant Professor of Optics and Photography at the Institute in 1922. He is a member of many scientific societies, and is president of the American Optical Society.

EDWARD V. RICKENBACKER, who wrote the article on *Airlines* for this issue, is General Manager of Eastern Air Lines. He went into airline executive work in 1932 when he became Vice President of American Airways, Inc. and assistant to the President of the Aviation Corporation. The next year he became Director of Public Relations for North American Aviation, Inc. and in the early part of 1935 was transferred to Eastern Air Lines, a division of the corporation. In 1919 he organized and became Vice President of the Rickenbacker Motor Company. In the year 1928-9 he was Assistant General Sales Manager, LaSalle division, Cadillac Motor Car Co. During the war he distinguished himself while serving as Commanding Officer of the 94 Aero Pursuit Squadron. He was credited with 26 victories and was the recipient of many medals of honor.

THE COVER AND FRONTISPIECE

IN order to aid the layman in understanding the general set-up of his body and the functions of its principal organs, a "Hall of Man" has been built at The Buffalo Museum of Science with a fund donated by Oliver Cabana, Jr. The cover of this issue of *The Tech Engineering News* shows the head of a transparent cellon model of a man, built life-size around a complete human skeleton, and showing the principal blood vessels as well as the chief organs. Lights installed in the brain, larynx, thyroid gland, left and right lungs, heart, liver, gall bladder, pancreas, spleen, stomach, appendix, small and large intestines, rectum, kidneys, and urinary bladder flash in unison with panels at the bottom of the model giving the names of the organs. To facilitate intimate study of the three-dimensional character of the organs in their relation to each other, models of the head and torso have been built representing a body cut lengthwise and across in sections about two inches thick, so that they can be separated or assembled mechanically by the observer.

A life-size x-ray photograph of the entire body of a living man serves as an example of the use that medicine has made of advances in science to aid it in serving mankind. The framework of the body, the skeleton, is clearly shown by this photograph and two skeletons, one disarticulate, the other assembled and made to move by electricity. The movement of the head in nodding is demonstrated, as is also the movement of the ribs in breathing. Another model, consisting of a rubber balloon suspended within a box but open to the outside air, shows the method in which the lungs operate. When the convex bottom of the box is made to flatten, the balloon swells, as the lungs do when the diaphragm is flattened.

The biggest and most imposing exhibit in the "Hall of Man" is properly a model showing the circulation of the blood, since the heart and blood vessels are of vital importance. This organ, as the model demonstrates, contains four chambers, two on each side. Those on the right do little work, merely forcing the blood through the lungs for purification. But the left side, by the strength of its lower chamber, drives the blood surely and continuously through the last tiny capillary of the most remote tissue. Since it is impossible mechanically to reproduce Nature's method of expansion throughout the whole mass of the heart, an external pump is used in the model to force the "blood" through the "heart" and vessels. Inside the glass heart chamber replicas of the valves which open and close as the fluid rushes in and out can be seen. The intricate journey of a single corpuscle is indicated by a tiny light coursing through the vessels.

The hall is arranged so that even a cursory visit will impress the visitor with the amazing intricacy of the human machine. "It is hoped that a study of the exhibits will stimulate curiosity to learn more, encourage habits of personal health, and engineer a greater appreciation of the great discoveries of medicine."

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THE TECH ENGINEERING NEWS

FEBRUARY, 1936
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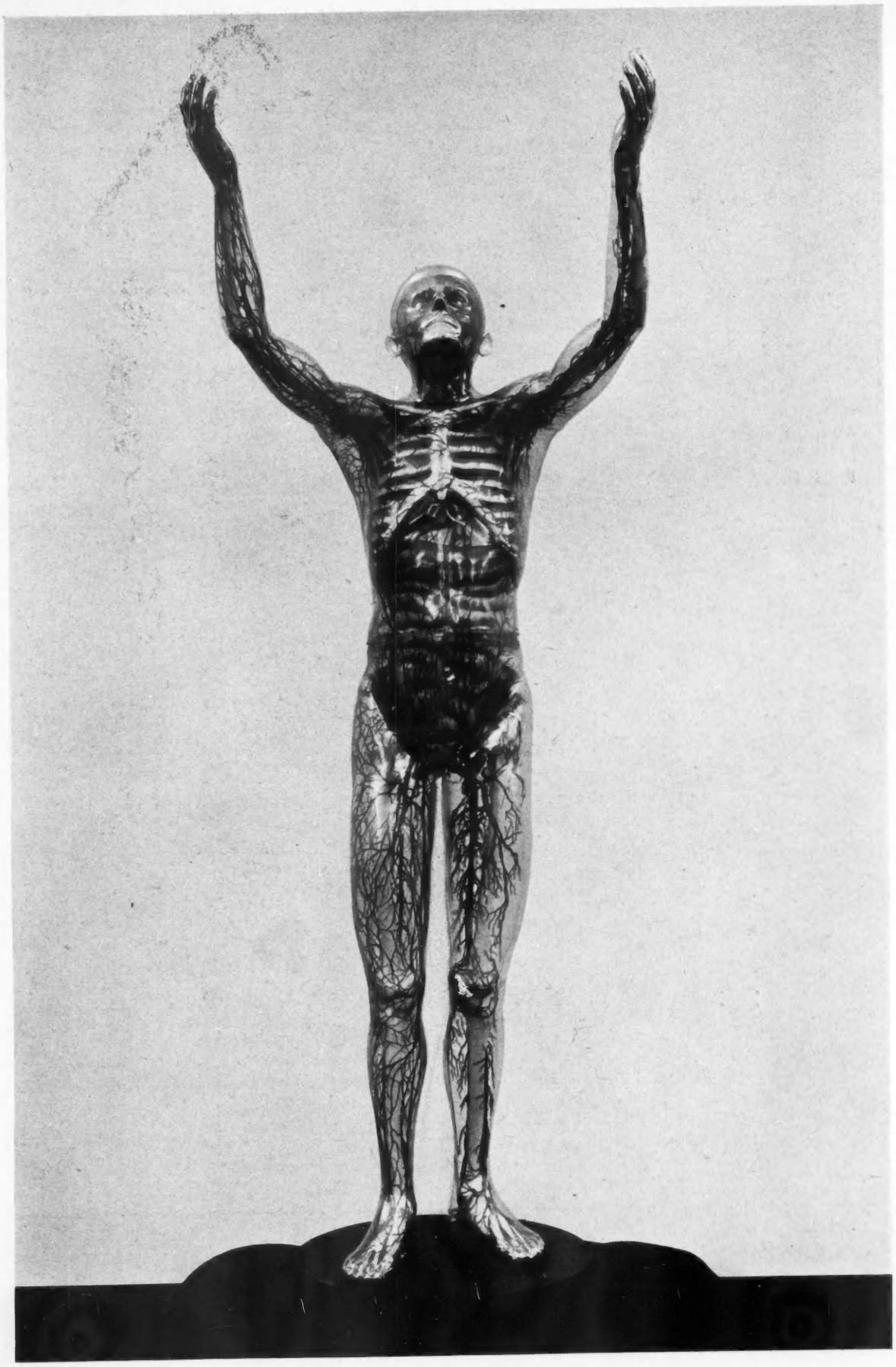
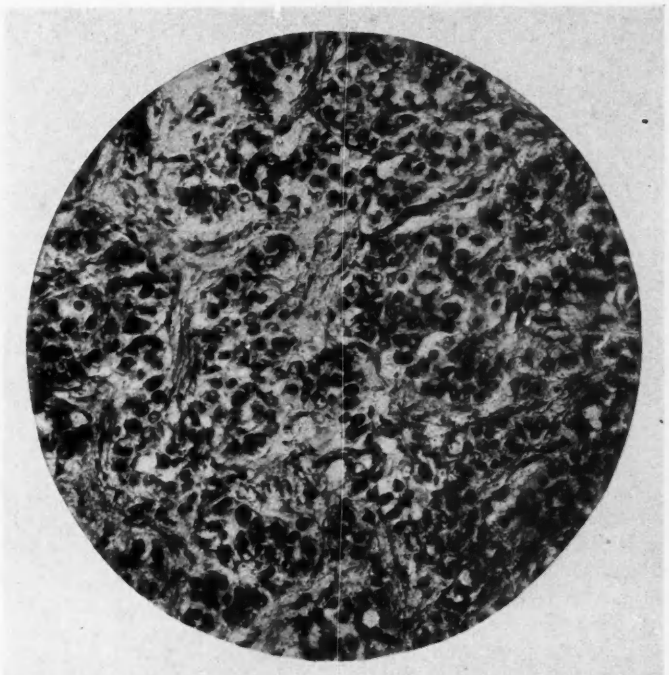


TRANSPARENT MAN

The Relationship of CANCER *and Organic Chemicals*

By AVERY A. MORTON
Professor of Organic Chemistry

WITHIN the last twenty years a new approach has been made in man's persistent attack on cancer. Certain pure organic compounds have been found to be capable of inducing malignant growths in mice. The first of these substances, 1, 2, 5, 6-dibenzanthracene, was the product of the laboratory originally synthesized for reasons far remote from cancer. Another, 1, 2-benzpyrene, was isolated from coal tar, and still another, methylcholanthrene, was obtained by chemical degradation of an acid present in the bile. The struture of these agents has been determined and the carcinogenic activity of related patterns has been studied. Extensions of our knowledge of cancer-inducing power to structural forms quite remote from the original discoveries have been made. Work is now in progress to ascertain if such substances may be formed in the body and how they produce malignant tumors. The ultimate goal of all this world-wide research is to eliminate this disease from its position as an active agent of death among adults. An account of the work is replete with the romance of discovery and the persistence of true scientific inquest. In 1915 two Japanese investigators, Yamagiwa and Ichikawa, observed that cancer could be induced in mice by repeated paintings on the skin with a solution of coal tar. Previous to their work the origin of cancer had been ascribed to protozoa, bacteria, or viruses. This discovery suggested that a chemical agent, present in coal tar, was playing an important role in the inception of the disease. Research workers, therefore, hastened to test the pure compounds which up to that time, were known to be present in such tars. Reports of cancer producing activity by some of the substances were made from time to time but in the final analysis only one out of twenty-seven compounds tested could definitely be charged with causing malignant growths. Indeed the activity of that compound, chrysene, was so very slight that there was considerable doubt for a time as to whether it really had any effect.



Wilford Nusbaum, M.D., Amer. Journal of Cancer

Photomicrogaph of tumor in the stomach.

Testing of these compounds was only one road leading out of the discovery of the Japanese workers. Another logical path was the study of tars made by different methods and derived from different sources. Schroeter, a German, discovered in 1920 that tetralin, in contact with anhydrous aluminum chloride at 37° for 18 hours, furnished an active tar fraction. In England Kennaway found in 1925 that isoprene and acetylene, when heated between 700–920° yielded tars which were carcinogenic. Acetylene, treated with anhydrous aluminum chloride, also gave rise to a potent tar. These results made it apparent that pure hydrocarbons could be condensed to yield active agents. Hence the cancer-producing substance need contain only the two elements, carbon and hydrogen, probably combined in the form of a condensed aromatic compound.

An attempt was then made to link the cancer-producing activity with a physical measurement. It had long been noted that coal tar hydrocarbons were fluorescent. After examination of the fluorescent spectra of a large number of cancer-producing tars, Hieger, working with Kennaway in London, noted in 1930 the frequent recurrence of bands at 4000, 4180 and 4400 A. The available list of hydrocarbons, whether in or out of coal tar, was then combed by Cook, in the same laboratory, for compounds with fluorescent bands in these positions. Very similar fluted bands were found in 1, 2-benzanthracene, whose carbon framework is shown in Figure 1. This compound, in itself very feebly, if at all active became definitely carcinogenic when substituents were put in the positions numbered 5 and 6. Curiously enough, of the three substances containing five rings pictured in skeleton form in Figures 2, 3, and 4, only the first was found to produce cancer. This compound, called

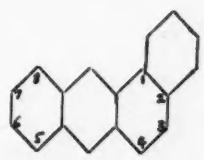


FIG. 1

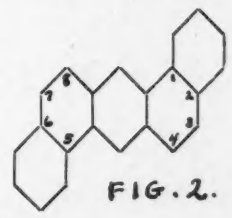


FIG. 2.

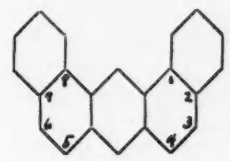


FIG. 3

FIG. 4

1, 2, 5, 6-dibenzanthracene, had been synthesized a short time before by Klar in Germany and by Fieser at Harvard, for purposes far removed from cancer. It was the first pure organic compound of unquestioned activity in inducing cancer to be discovered. It was later shown to be unnecessary to have a ring structure attached at the 5, 6-positions. Thus the dimethyl derivative shown in Figure 5 exhibited a high potency and monomethyl derivatives at either the 5 or 6 position were effective. The reason for lack of activity in the case of the compounds shown in Figures 3 and 4 has not yet been explained. None of these substances have been isolated from coal tar nor are the fluorescent bands absolutely identical with those of the coal tar compound. If they are present in such a complex mixture, their separation has so far defied the efforts of the chemist.

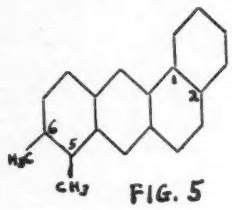


FIG. 5

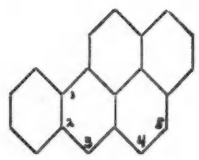


FIG. 6

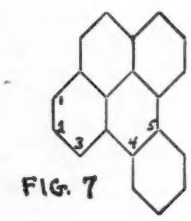


FIG. 7

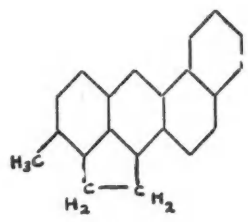


FIG. 8

Faced with the knowledge that an active agent was present in tar why did not the research workers at once begin the isolation of this cancer-producing material? Man as well as nature is prone to make generous concessions toward the easier course, particularly when the alternative route is so rough and jagged. The separation of the compounds already known to be present in coal tar had in itself been a difficult task. To ferret out the unknown agent was like sifting the straw for the proverbial needle. Hieger's work on the fluorescence spectra provided a quick test by which the potency of the various fractions could be approximated without the long period, 3 to 12 months, necessary for the tests on mice. Imperfect though this gauge later proved to be, it was extremely useful in this instance as a control test. The separation and identification, a classic example of persistence, ingenuity and care, was reported by Cook and a co-worker in 1933. Two tons of a medium soft pitch known to be cancer producing was subjected to a number of distillations, extractions, separation of picrates, and crystallizations, the progress at each step being checked by the fluorescence spectra as well as by some actual tests on mice. Their efforts were rewarded by the isolation of 54 grams (0.003%) of a crude compound which was strongly carcinogenic. This material was by no means the only one active in the original tar for some other fractions equally potent were discarded during the work because the further separation proved extremely difficult. This one compound was much more active in producing cancer than any in the former series. After further purification, the usual combustion to determine the percentage of carbon and hydrogen, and the molecular weight determination, the structure was guessed to be one of two likely configurations (Figs. 6 and 7). Synthesis of both of these possibilities was effected by Cook and the new cancer-producing compound was shown to have the structure of 1, 2-benzpyrene whose carbon framework is pictured in Figure 6. The other suggestion; 4, 5-benzpyrene, is shown similarly in Figure 7. It did not induce cancer for reasons as yet undetermined.

The brilliant work of the London investigators uncovered another source of carcinogenic hydrocarbons which has attracted a large amount of attention. Slightly earlier work by Wieland in Germany on the complex organic compounds in the bile, known as the bile acids, had shown that they could be degraded by various steps in the laboratory to a material called methylcholanthrene (Fig. 8). It can be seen at a glance that this substance is similar in its general outline to benzanthracene with substituents in the 5 and 6 positions (See Fig. 1). Cook and co-workers demonstrated the relationship further by tests upon mice. The activity of this compound is as high as that of 1, 2-benzpyrene if not indeed higher. Obviously if the chemical processes occurring in the laboratory have any parallel with those in the body, we have a material

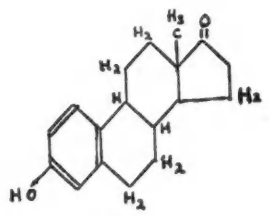


FIG. 9

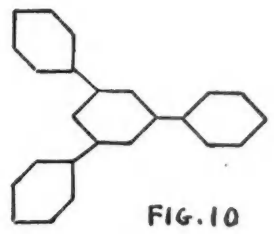


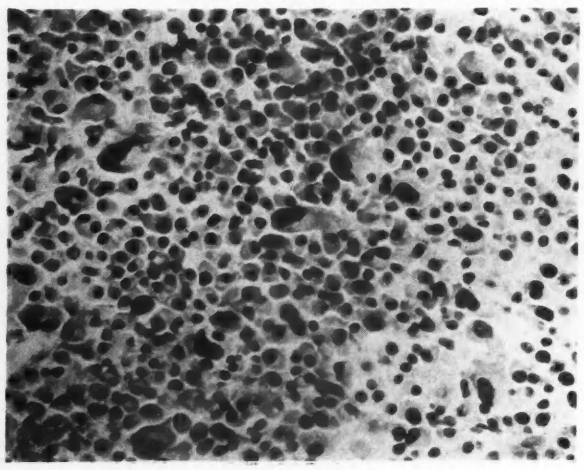
FIG. 10

already present in the human system which can serve as a source of cancer-producing hydrocarbons. Prior to this discovery Kennaway and Cook had pointed out that the carbon frame-work of the hormones, vitamin D, cardiac poisons, and certain vegetable alkaloids was similar in some respects to that of the carcinogenic compounds. The structure of the oestrus hormone is shown in Figure 9, and the carbon framework of the other hormones is very similar. By converting the hydrogenated rings to aromatic nuclei and removing the oxygen atoms a hydrocarbon is produced which has a similarity to part of the benzanthracene molecule. In short it appeared that a deranged metabolism of naturally occurring compounds might be a cause of cancer.

The power of suggestion is very great. Although Kennaway and Cook were careful to point out that the successive steps from the natural products to the active hydrocarbon

(*Continued on page 174*)

C. F. Geschikter, M.D., Amer. Journal of Cancer



Malignant plasma-cell tumor of the nose.

A New Deal for COLOR *—the Colorimeter*

By ARTHUR C. HARDY
Professor of Physics

TO understand the metamorphosis that the subject of color is undergoing, it is necessary to go back approximately 50,000 years to the time when some of our ancestors learned to decorate the walls of their caves with coloring materials that they dug from the earth. This was probably man's first use of color for decorative purposes. Those mineral colors, a few vegetable dyes, and some substances obtained from certain insects and mollusks were the only materials available for many centuries. In fact, the paucity of suitable materials was not remedied until after Perkin's synthesis of mauve from coal tar in 1856. This discovery led to the production of literally thousands of new synthetic dyes and pigments. Since that time, the organic chemist has been so industrious and so successful that the lack of suitable coloring materials has now ceased to be a serious problem.

The present metamorphosis is the result of a transfer of emphasis from problems of a purely chemical nature to problems that reside more in the field of physics. It is obvious that such should be the case because, in contrast to the earlier situation, commercial coloring materials nowadays have such a high purity that an almost infinite variety of colors can be obtained by mixing two or more materials. The color of these mixtures does not follow from the laws of chemistry because chemical reactions between the components rarely take place. Instead, this subject may be attacked by application of the laws pertaining to the branch of physics known as optics.

Just as chemical analysis is the basis of all progress in chemistry so color analysis is the basis of progress in connection with the optical behavior of dyes and pigments. In the vast majority of color problems one is concerned with the color of reflecting surfaces such as textile fabrics, or films of paint, ink, lacquer and enamel. Although an analysis may readily be made of the color of a light source or a piece of colored glass, this discussion of the principles underlying color analysis will be restricted to the case of reflecting surfaces. Suppose that a surface whose color would ordinarily be described as green is illuminated by a beam of approximately white light. Imagine that a prism is interposed in the beam between the source and the test sample. This prism separates, or disperses, the light into its spectral components—violet, blue, green, yellow, orange, and red. Consider for a moment only a single component—the violet, for example. When the violet light strikes the surface, a portion is absorbed and converted into heat. The remainder, if not transmitted through the material, is reflected. We can easily imagine a surface that does not possess the power of absorbing violet light. Such a surface would therefore reflect all the light that falls on it and would be said to have a reflection factor of one. On the other hand, we can imagine a surface that would absorb all the violet light that falls on it, in which case its reflection factor would be zero. Evidently the reflection factor of the surface for light of a certain color must always have a value between zero and one. Experiment shows that the value of the reflection factor does not depend upon the intensity of the violet light nor does it depend upon the simultaneous presence of light from other regions of the spectrum. Hence, the reflection factor of a surface for violet light is one of its inherent characteristics. This argument applies with equal force to all the spectral components. An analysis of the color of the green test sample might therefore indicate the following:

Spectral Region	*Reflection Factor*
Violet	0.15
Blue	0.35
Green	0.32
Yellow	0.15
Orange	0.11
Red	0.06

The instrument by which reflection factors for various spectral regions are determined is known as a spectrophotometer. In principle, this instrument is merely a photometer arranged for measurements of reflection factors combined with a prism for dispersing the light into its spectral components. The earliest spectrophotometers were of the visual type. The observer, on looking into such an instrument, sees a divided field containing light from the test sample in one half of the field and the light from a standard material having a reflection factor of substantially 1 at all wavelengths in the

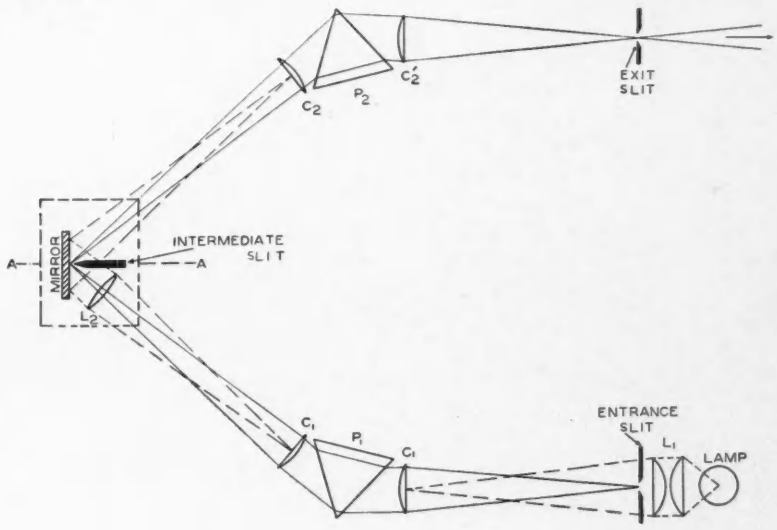


Fig. 1. A schematic diagram of a portion of the optical system of the recording spectrophotometer constructed for the Color Measurements Laboratory at M. I. T. Light from a tungsten lamp passes through the prism P_1 where it is despersed to form a spectrum along the line AA. By means of a mirror and slit, a narrow region of the spectrum is isolated, and is caused to pass through a second prism P_2. The wavelength of the light emerging from the exit slit is altered by moving the carriage supporting the mirror and intermediate slit along the line AA.

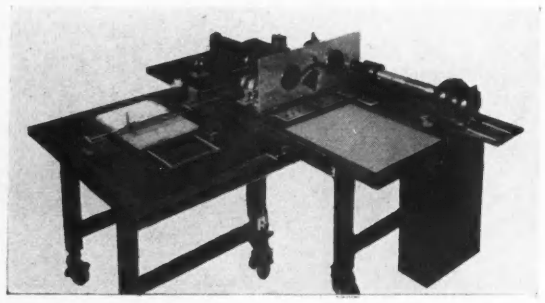
other half. In operation, the instrument was adjusted for a certain spectral region, and the beam from the standard was then reduced in intensity until the two halves of the field appeared to match. The amount of reduction necessary is a measure of the reflection factor of the test sample of this spectral region. By selecting other regions in turn, the entire visible spectrum could be covered. Although only six regions are indicated in the preceding table, it is customary to subdivide the visible spectrum into a larger number of narrow regions, usually thirty or more. As a result of such an analysis, it is possible to plot a curve showing the reflection factor as a function of the wavelength of the light.

To obtain a satisfactory color analysis with a spectrophotometer of the visual type is a tedious and time consuming procedure, since it is generally necessary to make from five to ten settings of each wavelength in order to secure satisfactory precision. Because this operation must be repeated at some thirty wavelengths, the total number of observations ranges from 150 to 300. The time required for making these settings and the fatigue experienced by the observer have prevented the use of spectrophotometers of this type for routine analyses. Largely for this reason, the Color Measurements Laboratory at the Institute undertook the development of an instrument in which the observer is replaced by a photoelectric cell.

A spectrophotometer of the photoelectric type, although inherently less fatiguing to the operator, does not necessarily yield results of adequate precision because photoelectric cells gradually change their characteristics with time. This difficulty has been avoided in the instrument developed at the Institute by exposing the cell alternately to light from the sample and from the standard, the light from the standard being reduced in intensity until the alternations in the cell current cease. Because the alternations take place at the rate of 120 per second, the characteristics of the cell may be assumed constant. Also, the effects of variations in the intensity of the light source or variations in the gain of the amplifier are eliminated. A schematic diagram of the optical system of this instrument is shown in Figures 1 and 2, and a brief description of its method of operation is given in the captions under these figures. A photograph of the instrument is shown in Figure 3.

The spectrophotometric curve of a material constitutes a permanent record of its color which obviates the necessity of maintaining a sample. That it is difficult to maintain color standards by means of material samples may be inferred from the frequency with which a question is raised concerning the color of the paintings of the old masters at the time they were painted. A cynic has remarked—"Perhaps they were good once." The point is that, good or bad, we have no way of knowing what they were like originally, despite the fact that artists have generally employed special care to select their pigments with a view to permanency. By means of spectrophotometry, however, a color record may be preserved in terms of the reflection factor at each wavelength. Absolute

*A more complete technical description of the instrument will be found in the Jour. Opt. Soc. of Am., Vol. 25, No. 9, September, 1935.



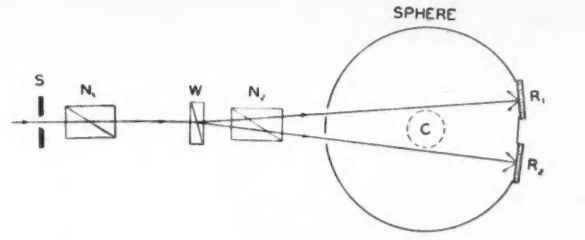


Fig. 2. A schematic diagram of the photometer unit. The slit S is the exit slit of the monochromator shown in Fig. 1. The light entering the photometer unit is plane-polarized by the Nicol prism N_1. It then passes through a Wollaston prism W which splits the beam into two beams that pursue slightly divergent paths. These two beams are polarized in mutually perpendicular planes, and their relative intensities depend upon the angular setting of N_1 with respect to W. The Nicol prism N_2 is mounted within the hollow shaft of a synchronous motor. As it rotates, it allows light to fall alternately on the white standard R_1 and on the test sample R_2. The light reflected by R_1 and R_2 is reflected by the white walls of the sphere is re-reflected by the white walls of the sphere into a window C in the sphere wall. A photoelectric cell is located just outside this window. If R_1 and R_2 reflect unequal amounts of light, the variations in cell current cause a motor to rotate N_1 to a position where the variations cease. The reflection factor of R_2 with respect to that of R_1 can then be read directly from the angular position of N_1.

methods of reflectometry are available that assure reproducibility of the white standard, and wavelength measurements can be made with higher precision than is attainable in the measurement of any other physical quantity. Spectrophotometry, therefore, provides a fundamental basis for color measurement, so fundamental in fact that any color could be readily duplicated even though every existing sample of it were destroyed. As an example of the usefulness of such measurements, it may be mentioned that the Institute some time ago recorded the Institute colors (cardinal and gray) spectrophotometrically. These curves are kept in the vault and make it possible for the graduate of some years hence to receive a diploma tied with ribbon of the same colors as that of his father and grandfather before him. Although the excuse for these measurements is largely sentimental, the importance of maintaining color standards in almost every line of industry is obvious.

Only by application of the concepts underlying spectrophotometry is it possible to understand the phenomena of color mixture. Everyone learns empirically, of course, that a mixture of a yellow pigment with a blue pigment will, in general, produce a green. This results from the fact that yellow pigments generally absorb strongly (reflect poorly) in the blue and violet, whereas blue pigments usually absorb strongly in the yellow, orange, and red. In a mixture of the two, the reflection factor is low except in the green where neither pigment absorbs to any great extent. Unless the problem is complicated by such factors as a great disparity in the size of pigment particles, it is generally possible to compute the spectrophotometric curve of a mixture from the

Fig. 3. A photograph of the spectrophotometer whose optical system is represented in the preceding figures. On the left is a recording table which is mechanically connected to the motor that drives the mechanism for changing the wavelength. The pen is driven by the motor controlling the prism N_1. In this way, a complete spectrophotometric curve for the visible region of the spectrum is obtained in from two to four minutes.

spectrophotometric curves of the components. The converse of this problem is, of course, of more general interest—namely, to determine how a given green should be matched. Usually the spectrophotometric curve of the green indicates the pigments composing it. If the characteristics of these pigments are known, it is then possible to compute the proportions that are required for a match. Such a procedure is in marked contrast to the usual methods of color matching which are often time consuming and frequently lead to the introduction of too many components, some of which may be unsatisfactory either on the grounds of permanency or expense. It should be added that, if a match is made under spectrophotometric control, it will be valid under any type of illumination. This is frequently not the case when the match is made in the conventional manner.

Spectrophotometric curves are at first somewhat confusing to those who are not acquainted with them, chiefly because the curves provide so much more information than can be obtained by visual examination. Unlike the ear, the eye is incapable of analyzing a stimulus into its components. For example, such a common source as sunlight is not intuitively resolved into the various spectrum colors that it contains. To be sure, those who are accustomed to mixing dyes and pigments sometimes claim the ability to see in the resulting mixture the components which they have added. This is not analysis but merely a judgment based on experience. Because the eye lacks analytical powers, the spectrophotometer somewhat overspecifies a color. Although, as mentioned above, the spectrophotometer is necessary for the maintenance of standards, for the interpretation of the phenomena of color mixture, and for the securing of color matches that will be valid under any type of illumination, there are other problems for which a specification containing no more information than is possible from a visual examination would be adequate.

The type of color specification that corresponds most closely to the results of introspective analysis is a specification in terms of brightness, dominant wavelength, and purity. The concept of brightness has here its usual photometric significance. In the customary form of specification, a brightness of 100% is arbitrarily assigned to a white surface that is a perfect reflector. An absolute black would, of course, be represented by a brightness of zero. The color of any white, black, or gray surface can then be specified completely by merely designating its brightness. In the case of any other color, values must also be assigned to the other parameters—dominant wavelength and purity. The dominant wavelength is, so to speak, the wavelength in the spectrum to which the color in question most nearly corresponds. An exception is made in the case of purple samples because purple is not a color of the spectrum. Its dominant wavelength may be indicated, however, by stating the dominant wavelength of a color (usually green) that is complementary to it. The purity of a color indicates the closeness with which it approximates a spectrum color of the same dominant wavelength. A purity of 100% is arbitrarily assigned to the spectrum colors and a purity of zero to a white, gray, or black. This type of color specification will be understood by reference to Table I, which indicates the brightness, dominant wavelength, and purity of typical samples of familiar colors.

TABLE I

	Brightness	*Dominant Wavelength millimicrons*	*Purity*
Cardinal	9%	617	55%
Baby Pink	50	610	10
Old Rose	23	608	20
Blood Red	17	600	65
Maroon	7	600	35
Henna	8	587	60
Chocolate	5	586	30
Russet	12	585	45
Goldenrod	45	576	70
Ivory	55	575	25
Olive Green	14	572	45
Apple Green	35	567	40
Turquoise	32	500	30
Lupine	32	476	27
Slate	12	476	10
Navy Blue	3	475	20

Instruments known as monochromatic colorimeters have been constructed which enable a colored sample to be matched by a mixture of white light with spectrum light of the proper wavelength. The brightness, dominant wavelength, and purity can be determined directly with an instrument of this sort from the wavelength of the spectrum light, its intensity, and the intensity of the white light. Such instruments are seldom used, however, because they tend to accentuate even minor peculiarities in the observer's visual process. Even though two observers are normal by all ordinary tests for color brightness, they may still obtain different settings with a monochromatic colorimeter. Hence, a large group of observers must be employed if results of general significance are desired. An alternative procedure is to determine certain basic data concerning the response of the normal observer to light of each spectral component. This has been done for a large number of observers by two independent investigators. The results were summarized and published by the International Commission on Illumination which met in Cambridge, England, in 1931. As a result, it is now possible to compute the values of brightness, dominant wavelength, and purity of a color that would be obtained if this group of observers were to use a colorimeter of the monochromatic type. The computation is based upon spectrophotometric data and it therefore provides as fundamental a basis for color specification as spectrophotometry. The calculations are somewhat involved and no attempt will be made here to indicate the

(*Continued on page 173*)

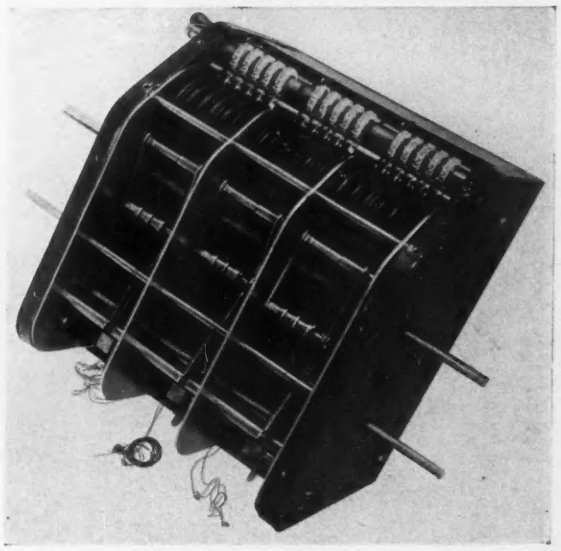


Fig. 4. A computing machine built for attachment to the recording spectrophotometer. This will automatically add the reflection factors of the test sample at three hundred wavelengths as rapidly as the values are obtained. The final numbers shown by the three dials can be readily converted into brightness, dominant wavelength, and purity.

TWA
NC14282

Systematic

AIRLINE OPERATION

and Maintenance

By CAPTAIN E. V. RICKENBACKER
General Manager, Eastern Air Lines

NEVER before has the subject of transportation fired the imagination of man with the enthusiasm that aviation arouses today. To the person on the street the fulfillment of commercial schedules whereby giant airliners unite any points of the United States within twenty-four hours, and the early promise of inauguration of commercial schedules whereby clipper ships will girdle the globe in ten days, resemble the workings of a gigantic Alladin's Lamp. To him achievement of these wonders never loses its fascination; they open new vistas of thought and cause him literally to flick his eyes for assurance that they are not sub-conscious fantasies.

To the person off the street, however—the pilot in the plane, the engineer in the laboratory, the radio technician at the ground station, the mechanic at the hangar, the dispatcher and even the ticket seller—there is nothing mystical or supernatural about the flight of a transport plane from New York to Miami in eight and one quarter hours or New York to Los Angeles in sixteen and one-half hours. And to them there is nothing incredible about plans for linking the major cities of the world by air in something like one-tenth of the time required by other modes of transportation.

Fascinating, certainly, but that is where the resemblance of aviation to an Aladdin's Lamp ends.

Behind the scenes in air transportation are found practical, substantial, far-sighted men, constantly planning for tomorrow, yet with all the faculties at their disposal concentrated on today. These men have set up systems of operation and maintenance for every phase of airline operation.

Their persistent process of observation and reconditioning to which they subject the airliners is of such uniformity and exhaustive thoroughness as to insure perfect condition of equipment at all times. This completeness of operating detail is evidenced in the procedure followed by one of the major airlines, and which is in general the same as that followed by all airlines. The airline institutes the system upon the new airliner immediately after acceptance and it is followed through

Aero Digest

The heart of the Douglas Transport which is one of the many factors insuring safe, dependable, and speedy service.

and repeated consistently until the craft is retired from service, usually after a period of about two to three years.

One hour before an airliner is sent out on a scheduled flight it is put through what is known as a trip check. This consists of inspection of flying and engine instruments, radio equipment, flight controls, brakes, and propellers, together with a test of the engines. After every 25 hours of flying, approximately equivalent to a round trip between the Atlantic and Pacific coasts, the landing gear is carefully inspected as to condition of wheels and retracting apparatus, after which the wheels are jacked up in position for mechanical and manual control tests.

A more detailed inspection takes place every 50 hours at which time engine mechanics perform a complete valve check, inspection of gasoline and oil strainers, check the propeller mechanism, and change the oil. At the same time other mechanics are testing the electrical, heating and cooling, and ventilation systems.

Upon completion of a 100-hour period by the airliner, during which time it has covered approximately 16,000 miles, the ship is divided into seven sections and completely gone over and minutely inspected for signs of wear. Adjustments are made as noted on logs where the pilot or co-pilot has denoted any desired change. In addition to the complete overhauling of the body, the engine is given a close inspection as to condition of cylinder heads, rocker arms, magnetos, and controls.

The company's radio experts also make a thorough examination and take care of any necessary adjustments to the ship's radio receivers and transmitter.

At the end of the 350-hour period, which generally comes after about two month's time, the motors are removed from the planes and completely torn down together with the accessories, after which, each part is separately checked to determine its condition. Those parts which are worn or found defective are replaced and the motor is reassembled.

AMERICA TAKES WING.

Pictured on the opposite page are the type airliners in service on the eleven major air lines of the United States. They are identified below as to type and owner.

Vultee V-1A
Bowen Air Lines.

Stinson-A
Central Airlines.

Boeing 247-D
Pennsylvania Airlines.

Boeing 247-D
United Air Lines.

Douglas DC-2
Eastern Air Lines.

Martin Clipper
Pan-American Airways.

Douglas DC-2
American Airlines.

Douglas DC-2
TWA.

Lockheed Electra
Northwest Airlines.

Boeing 247-D
Western Air Express.

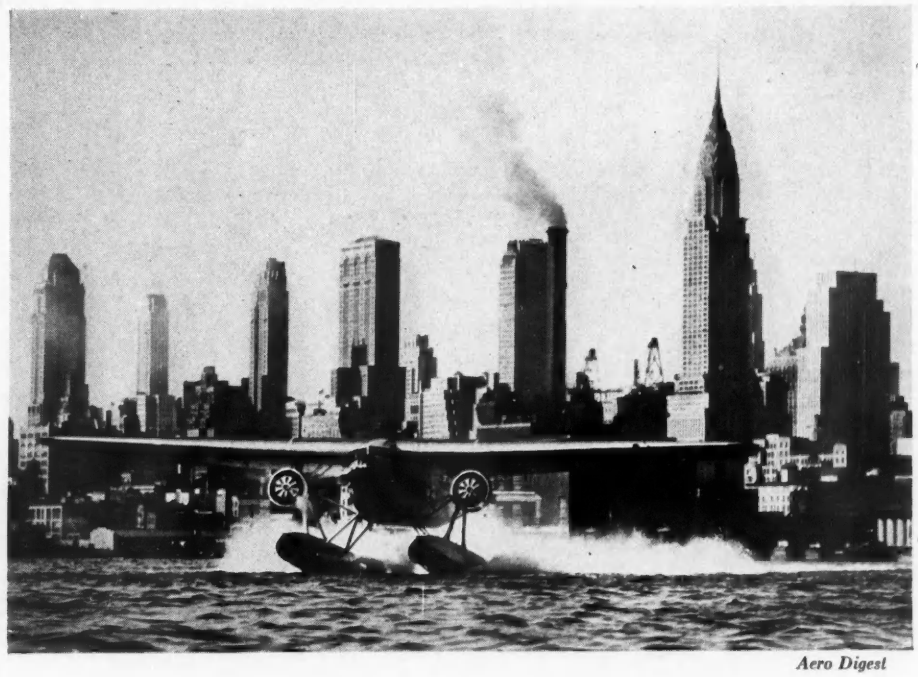
Lockheed Electra
Braniff Airways.

The propellers are taken to their special department where they are disassembled and carefully inspected. The 600-hour check is a duplication of the 350-hour check, but this time the instruments are disassembled, and an entirely new panel installed, as well as a thorough inspection for any possible corrosion, and in addition the cables are stretched and sound proofing is checked.

This system of maintenance is matched by an equally methodical method of operation which insures the highest type equipment and personnel.

Radio is one of the prime factors in systematic airline operation, serving as a medium for communication and for the transmission of signals which enable the pilot to keep his plane on course. In the period of less than ten years since two-way radio was first used by the airlines with any measure of efficiency, the airlines have been bending all efforts toward a completely unified communications system. As a result, the airliners of today are equipped with efficient radio transmitters and receivers which enable the pilot or co-pilot to be in constant contact with one or more radio ground stations.

The co-pilot reports the position of his plane every thirty minutes. Information such as special weather reports and advice to pilots regarding field conditions are made whenever required. Also by means of the radio telephone, planes may communicate with each other directly, the pilot has only to pick up the microphone and call some other plane in order to obtain any information which he desires to procure from the other pilot. The radio equipment includes two receivers one of which, as aforementioned, is tuned in for the reception of communications from the ground stations or other planes which come over the short wave band, while the other is tuned to the frequency band which lies above the short wave and popular broadcast bands. Over this long wave band are broadcast the Department of Commerce reports of weather conditions along the airway and the beacon signals for guidance between ports in conditions of bad visibility. It is evident, then, why airliners carry two receivers, for reception must often times be carried on simultaneously over both bands.



Aero Digest

A Manhattan Island Terminal; service to start very shortly by 3 of the large airlines, thus to eliminate the delay formerly encountered in getting from the city to the airports.

Aero Digest

Another of the vital phases of airline operation of today is the system of weather forecasting. Recently what is known as the "air mass" system of air analysis was introduced into general usage in this country. This type of forecasting originated in Norway and is based upon the hypostasis that weather conditions arise from the presence in the same locality of two masses of air of different intrinsicalities. By the use of this system and information as to atmospheric conditions in different parts of the country, obtained from the Department of Commerce, the meteorological personnel are able accurately to predict weather conditions at any point along the airway for a period of over six hours in advance. By use of this system the pilot learns before he goes out what conditions he will find along his route. He may then plan his flight with much greater efficiency than was heretofore possible.

Research is in progress the year around in all transportation organizations, because only through research have they made the strides of today and only through research can the groundwork of tomorrow be laid.

As an example, Eastern Air Lines, like all forward-looking aviation transport companies, is vitally interested in stratosphere research. Recently the mete-

(*Continued on page 173*)

The control center of Newark Airport which regulates the movements of ships in the air and on the ground, by radio.

RUTS OF STAGNATION

By F. ALEXANDER MAGOUN, '18
Associate Professor of Humanics

"THE only difference between a rut and a grave is in their dimensions," says Helen Glasgow, and she is almost right. She forgets that men in a rut often prove a stultifying bondage to others, whereas the cold, dead hand seldom reaches up from the grave to preserve the *status quo* for very long. But the rut and the grave are at least alike in that both are occupied by people who have ceased to learn and possess no ability to think along new lines.

"The old fossil!" said a young lad of my acquaintance seeking to describe, with a terse and elegant phrase, someone many years his senior. "No," objected the boy's mother, "A fossil was alive once!"

Because college boys are all very much alive with an unrest that is almost infectious; because they are pardonably preoccupied with such mighty affairs as love, the befuddled hopes of a great career, and the pungent contradiction of science vs. religion—because of these things, they give little thought to the lurking danger of stagnation. Of the grave itself they think little subjectively and say less; of that living grave, the rut, they think introspectively not at all. Uncle Julius may be an old fossil, but petrifaction already creeping through their own veins? Never!

Wherever a long period of habit formation has taken place with no fundamental change and no improvement, stagnation is inevitable.

Where, then, are the college boy's vulnerable areas?

To begin with, by the time he earns the cap and gown he is likely to be pretty well satisfied with himself; not overly satisfied with this laggard world perhaps, but satisfied with himself. "The greatest cause of stagnation," says Elliott Dunlap Smith in accents which compel deep thought, "is self-satisfaction." Because he possesses a sheep skin which attests the fact that he belongs to the select company of intellectual men; because he has studied only when and as directed—a stimulus entirely lacking after graduation—the college man is in grave danger of thinking that he knows it all. This is the particular weakness of the Technology man who goes into an engineering office; the Dartmouth graduate, who has majored in philosophy, enters the dry-goods business much more conscious of his ignorance of department stores.

The great work of the world has been done by men who were entirely dissatisfied with what they had accomplished and what they knew; men who succeeded in thinking out old situations from unconventional points of view; men whose intellectual patterns were not in ruts despite the difficulties we all feel when our thoughts try to cross a frontier. There was Archimedes, for example, discovering a new and far reaching physical relationship instead of shouting impatiently for a slave to come mop up the bath water; Isaac Newton, stimulated to profound reflection by the thump of an overripe apple (the same which got Adam and Eve into trouble and which had beat upon the numb brains of a thousand fulminating yokels before Sir Isaac had asked "Why?" instead of exclaiming "Damn!"); Albert Einstein, unwilling to accept Newton as final despite the fact that the cream of gravitational truth had probably been skimmed before.

None of these men had stagnated into merely thinking what others had thought before them. Where other minds followed the time-worn ruts, their minds were pioneering untrodden ways.

In short, the great source of stagnation, as indeed of most weakness, is in the mind. From this point of view it has always seemed to me one of Homer's major psychological triumphs that he had Thetis dip the child Achilles into the waters of the River Styx in such a way that the boy's vulnerable point was in his heel, not his head. Not all present day, football-conscious mothers would have been so wise.

Stagnation comes quickest to the man whose habit patterns do not change. This is easy to see when applied to the draftsman who leans over a drawing table, to the technical assistant making endless identical analyses of multitudinous samples of water, to the misguided though strenuously Christian clergyman who uses the same barrel of sermons over and over again. It is less obvious but equally applicable to the engineer, the scientist, lawyer, physician, executive, or what-have-you who fails to provide regular, inescapable checks to shake himself out of the rut which threatens to overwhelm and swallow him so comfortingly.

How?

To begin with write an annual report on yourself intended for no other scrutiny but your own. Let it include a financial statement—with comparisons to previous years—of earnings, savings, and distribution of expenditures. Let it list the magazines and books you have read during the year with a careful estimate of *how that reading has changed your opinions or enlarged your mental horizon.* Let it investigate what things have made you very happy and what very angry and why. What original ideas have you had? What professional papers have you written? Let your report dwell coldly upon such questions as "What have I gained?" "What have I given?" "What have been my dilemmas?" Dilemmas vary all the way from, "Shall I shave every day or every other day?" to "How can I sift the truth from the propaganda that comes out of Washington and what should be my reaction to it?"

Make a personal five-year plan and then check on its accomplishment. If, over a period of years, you will write such an annual report, by examining a series of them it is easy to see whether your progress has been philosophical, financial, intellectual, and emotional, or only financial. If it fails, analyze the failure. If you want to stagnate, stagnate, but don't go through life with a soul tooth-ache that your talents were never half appreciated.

We Americans are so prone to measure progress only in terms of money. How much wiser it would be to think in terms of time. Stephen Foster died in the Bellevue Hospital possessing the altogether sufficient and magnificent sum of $1.25. But how well he used his time to produce an imperishable stream of lyric beauty which will outlive the gold piles of those already forgotten men who in the 1850's would have written a personal annual report only in terms of sound mortgage loans and capital gains.

Other worthwhile stagnation slayers are available in the form of active membership in your professional society so that you are exposed to new developments in your field. Indeed, this is the very purpose of the professional societies. Unless you want to develop a one-track mind (i.e. stagnation in every field but that of your major interest) expose yourself to a little learning in some unbelievably irrelevant field: say, a University Extension course in Medieval painting. Gladstone —whose heart never dropped its leaves—began the study of Greek at age 70 and completed a translation of the odes of Horace when he was 83. Such men never have hardening of the mental arteries because they refuse to stagnate. Recog-

(*Continued on page 175*)

The Rudder

"FROSTBITES"

Sailing

"FROSTBITE" DINGHIES

—*A Recreational Activity*

By GEORGE OWEN, '94
Professor of Naval Architecture

EDITOR'S NOTE: *The Institute Committee, student governing body at Technology, has recently approved the organization of a Nautical Association which will foster sailing as an undergraduate activity. Professor Erwin H. Schell of the Department of Business Administration has been prominent in promoting the activity and in obtaining the donation of approximately thirty boats by the alumni. Professor George Owen, '94, the author, with Professor Walter C. Vose has organized a course of instruction in dingy sailing in which three hundred students are interested*

PROBABLY the most facinating aid to mankind's recreational activities is the sailing boat. As H. A. Calahan reminds us "Here, on shore, life is a hurly-burly. Out there on the water is escape. Here, the world is too much for us. Out there we are alone. . . . You cannot find that world of waters in a motor boat. The motor boat carries part of the shore with it, and at the approach of the shore, the gods of the deep go into hiding. . . . No, you cannot find the world of waters in a motor boat. You cannot help but find it in a sailboat . . ."

"Sailing boats are wise. They display a sound shrewdness born of the wind and the wave. They impart that wisdom to the sympathetic helmsman. . . ."

The sailing boat is as old as man's history and although machinery has nearly driven the sail from the open seas, yet the sail bravely holds its own among the coastal and river peoples of the world. As a purely recreational medium, sailing boats were never so numerous and never so popular as today.

A saving feature of the "Sport of Kings," especially in these days of over-commercialism of many of our sports, is its freedom from being operated for profit. Profiteering in this sport simply isn't or can't be done. As a corollary to this idea of "sport for sport's sake" there probably exists among yachtsmen a bigger and better "give and take" spirit than dwells in any other form of competition. Is it any wonder that our older yachtsmen are investing in little sail boats and employing experts to help teach their children the rudiments of yachting? Within the past few years several of our leading yacht clubs have established junior branches. These junior branches are officered and managed entirely by youths in their teens. A splendid guarantee for the future of yachting!

The degree of enjoyment in sailing seems to be in inverse ratio to the size of the boat, that is, the smaller the boat, the greater the fun. For many excellent reasons the small boat should be used by the novice to begin his sailing experience. The small boat requires less cost, both initially and for upkeep. Only in the small and light sail boat does one experience that feeling of "liveliness" or acceleration felt with every puff of wind and every wave. Also the probabilities of capsizing in the small light boat are such as to teach and encourage skill against this hazard. Among the many types of small sail boats, the so-called "sailing dinghy" appears to be best suited for both novice and the experienced sailor to obtain maximum enjoyment. The word "Dinghy" at the present date is applied to a type of small boat made use of as a rowing tender or work boat for a much larger craft. The Dinghy is rarely over 15 feet long. It usually ranges from 10 to 14 feet in length. Occasionally it is found desirable to equip a dinghy for sailing. This is done by building to a slightly wider breadth for stability and adding a sail or sails and a centerplate or centerboard to the rowing dinghy.

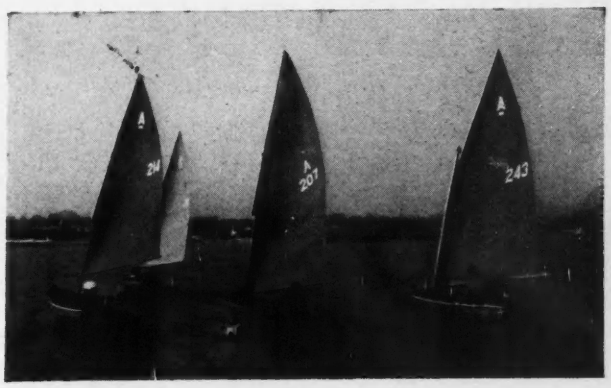
The model or shape of any type of boat is determined by the requirements of the service for which it is intended. The model of a sail boat intended primarily for racing purposes is determined by the measurement rules governing its classification. Because the Dinghy is usually carried on the deck or davits of its mother yacht, overall dimensions of length, breadth and depth and minimum weight are of first importance.

The so-called "Frostbite" Dinghy class originated about three years ago when groups of Massachusetts, Rhode Island, and Long Island Sound yachtsmen combined their ideas and agreed upon a conservative type of sailing-tender or dinghy of not over 11 feet overall length, of not less than 150 lbs. weight (without rig or centerboard) and carrying not more than 72 sq. ft. of sail. Although maximum and minimum restrictions were placed on overall beam, and a minimum limit placed on depth of hull, yet the desire for more speed inevitably led to changes in the rules and evasion of the spirit of the same, so that soon the fastest boats in this class had lost much of the safety and general usefulness originally intended.

In order to protect vested interests, the Frostbite dinghy class was divided. The original and conservative boats of 11 ft. overall length were rated in Class A, those more "racily" inclined were allowed to increase the length to 11 ft. 6 in. and to slack their bilges—at the expense of stability and safety—these were placed in Class B. Further, for the benefit of the more radical "research" group desiring more freedom in design, such as smooth, double or carvel planking, "wish booms," rotating masts, etc., the class was again subdivided to the "open B or O-B" class of frostbites. A very commendable feature of this entire "frostbite dinghy" group is the very high quality of design, construction, and rig existing among all of its boats. Such a situation is in pleasing contrast to many classes of little sail boats where, unfortunately, cheapness and shoddy construction are placed at a premium.

The recent movement among the students of the Massachusetts Institute of Technology to establish dinghy sailing as an additional student activity is a very significant and healthy sign. There are encouraging indications that several other educational institutions will do likewise in the near future.

(*Continued on page 176*)



Frostbiting at Larchmond Yacht Club. An unusual "shot" of the original class A boats.

THE TECH ENGINEERING NEWS

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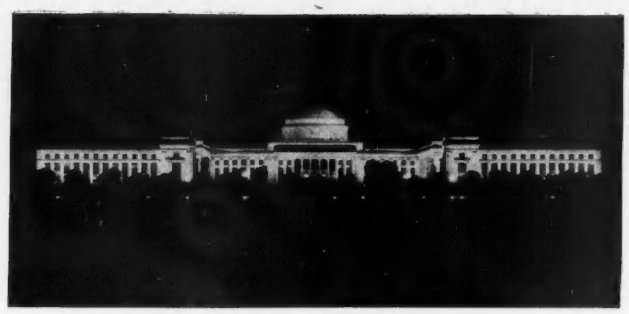


EDITORIALS

THE TASK IS UNFINISHED

WHEN the American Association for the Advancement of Science holds its annual convention, it acts as a lens bringing into focus a year's researches in many studies. Conventions of this sort offer opportunity for that exchange of ideas and interplay of minds which are essential to the growth of thought. They are consequently of great immediate and pragmatic importance.

Not in these capacities, however, does the primary significance of such meetings lie, not in the papers which are presented, not in the questions which are asked and answered, but rather, in the fact that the meetings can be and are held, that men are free to assemble, announce, and discuss scientific findings which in any one of a dozen categories are revolutionary, which upsets systems long established, but which are justified because they are the results of honest, searching, and judicious investigation.

Three or four centuries are, in the time-scale of civilization, but a short period in which to have progressed so far as we have from Galileo's forced recantation, from Copernicus's refusal to publish his theories. But though human reason has been so far liberated, still the recurrence of the repressive spirit in our own times and in widely separated parts of the world is admonition that its causes have not entirely been eradicated.

FREDERICK G. FASSETT, JR.
Assistant Professor of English.

PETROLEUM CONSERVATION

TOWARDS the last part of the nineteenth century our government awoke to the fact that the forests of the United States were disappearing rapidly, because of the greedy and short-sighted exploitation by the lumber companies. To prevent erosion and dust storms, Theodore Roosevelt introduced a policy of conservation and of reforestation. Now, with the efforts of the Civilian Conservation Corps, we feel reasonably sure that our forests will not be destroyed.

Forests are only one of a great number of resources. What is being done about the conservation of petroleum? The United States Geological Survey warns us that, at the present rate of production, our petroleum supply can last only thirteen years. Since a great part of our civilization depends upon gasoline and other refined oils, the seriousness of the situation cannot be over-estimated. Gasoline can be made from coal dust; in fact, the Germans have done it on a large scale. Yet here, the making of gasoline from coal is different, since

American coal is different from European coal. With this in mind, the United States Bureau of Mines wishes to investigate this problem. The cost of the research is modest, but the government has not yet appropriated sufficient funds to start it. Millions upon millions of dollars are being spent upon relatively less important projects; yet a few thousand dollars cannot be appropriated to the Bureau. Thirteen years will not last forever. Let us fervently hope that our government will awake in time to save us from a serious embarrassment.

THE FUTURE

FOR the last four or five years, graduates of Technology have left the sheltering walls of the Institute with well-founded misgivings as to their immediate future. Some, still having funds from home, have probably seriously considered letting the finals slip a bit so as to prolong the so-called agonies of college life and study. Today this feeling is changing. More and more men actually interested in their future are straining at the leash to get out into the business world.

The evidences of this period are becoming more abundant every day. Aside from the usual pep talks that filter through trade papers accompanied by imposing figures, there are real signs. One of these is the definite upward trend of volume in the durable goods industries. At the great Machine Tool Show held in Cleveland last September, there was great evidence of buying. Figures say that some $5,000,000.00 worth of tools were sold. Mr. Ralph Flanders, President, Jones and Lamson Machine Company, said "The machine tool is the only inanimate object which reproduces itself. This alone gives it a unique position among the man-made products of civilization." Thus when tools are selling everything is selling.

At a dinner given for Industrialists in New York, one of the most prominent topics of conversation was "where may I find technically trained men to fill out my departments and take care of the volume increase." These evidences are but few among many but they are real ones.

The whole economic set up lends itself to the advancement of the educated man who is starting in now. Whatever the government tries to do in line of increasing the individual wage must be met by individual's ideas on how to increase the individual output of those employed. The Tech man is peculiarly fitted to bring forth these ideas. Thus we see his future looking up.

POWER OF OPINION

MODERN science has made the warfare of today totally different from ancient warfare. In the time of the Romans, wars were fought by means of the sword, the spear, and the bow and arrow. Armies lived on the produce of the land they occupied. Soldiers followed fighting as a profession, because it gave them wealth (in plunder) and honor. Such a war cost little and paid dividends in the form of colonies and slaves; it actually benefited the populace of the conquering nation. In contrast, a modern war, such as the World War, brings deficits, not dividends even to the conqueror. It is fought with huge cannon, explosive shells, gas, machine guns, tanks, bombs, airplanes and battleships. As a result, it is both extremely destructive and very expensive. Armies no longer are self-sufficient, but must be supplied with large amounts of food, arms, and ammunition through the sacrifice and efforts of the civilians of the nation. Thus the burden of fighting the war is borne not only by the soldiers, but by all classes of people. In victory there is no plunder and but little honor for the soldier, and for the nation naught but shell-pitted and war-exhausted territory and the lasting enmity of the defeated people.

One great result of the difference between ancient and modern warfare is the changed attitude of the average person towards war. The ancient Roman looked on war as a lucrative, glorious profession followed by strong men and strong nations. The present average citizen looks on war as a wholesale murder of men and destruction of property—as a producer of poverty and bereavement.

Yet there are some who have failed to see the vital difference between war by the sword and war by explosives. Mussolini is an example of a man trying to play Julius Caesar in the Twentieth Century. He forgets that modern wars have cost more than they have produced, and that world opinion—a powerful weapon against even a dictator—is turning more and more against war.

CHANGES

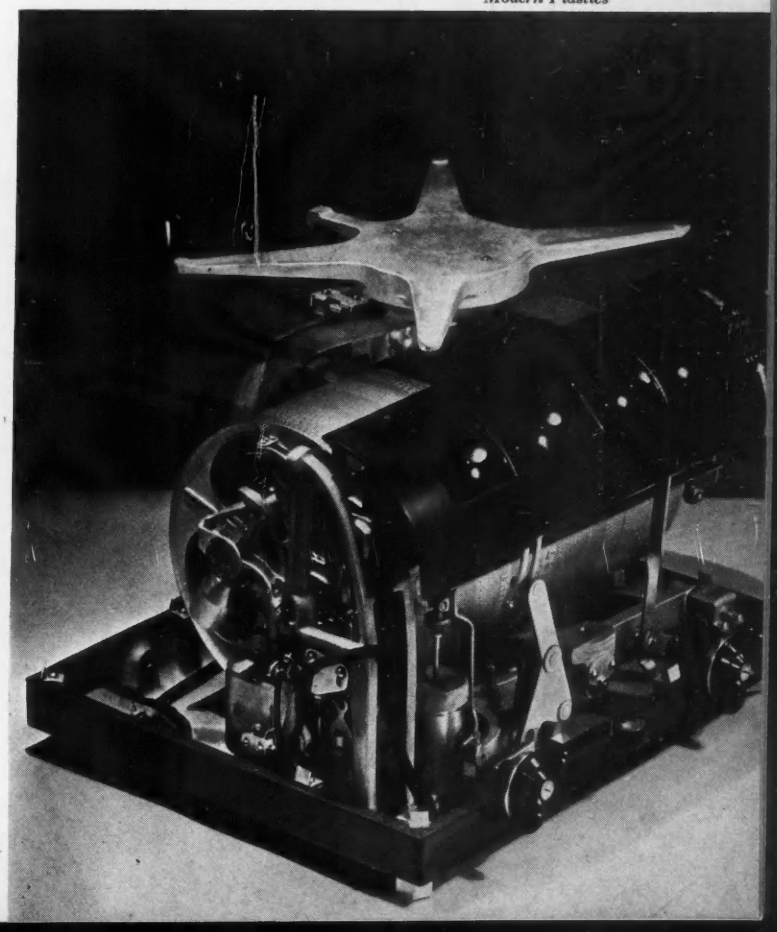
With this issue, the Managing Board of Volume XVI retires from office and passes on control of THE TECH ENGINEERING NEWS to the new Board of Volume XVII.

The Managing Board of Volume XVII will be H. Arthur Zimmerman '37, General Manager; Jervis C. Webb '37, Editor-in-Chief; Francis S. Buffington '37, Business Manager on the Senior Board. Comprising the Junior Board will be Dale F. Morgan '38 and Frank B. Kemp '38, Associate Managing Editors; Frank S. Gardner '38 and Harry O. Saunders '38, Associate Editors; Murray H. Hayward '38, Treasurer; John C. White '38, Circulation Manager; Richard A. Novak '38, Advertising Manager; and Robert L. Johnson '38, Publicity Manager.

In addition, the following elections to the Business and Editorial Departments have been made: James H. Owens '37 and James B. Hess '38, Contributing Editors; David A. Werblin '36 and John B. Allen '36, Art Editors; Dempster Christenson '38 and William Woodward '38, Associate Advertising Managers; and Walter Kaufman '38, Associate Circulation Manager.

To this new Board the outgoing Managing Board of Volume XVI wishes every success.

Modern Plastics



The development of synthetic plastics made possible a new design for the modern scale.

ENGINEERING DIGEST

STREAMLINED FERRY

THE Black Ball Ferry *M. S. Kalakala* gave Puget Sound, Washington, the first completely streamlined ship operated anywhere on the seven seas. The new vessel went into operation in July between Seattle and Bremerton, home of the Puget Sound Navy Yard and gateway to Hood Canal and the Olympic Peninsula.

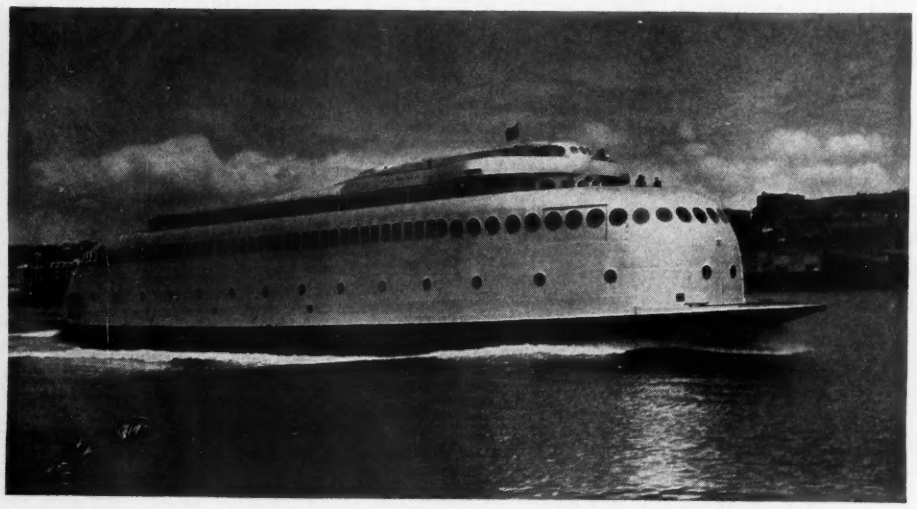
"Kalakala" (pronounced Kah-lok'-ah-lah) was taken from Chinook, the intertribal language of the Northwest Indians; it means "Flying Bird." And this ferry looks like a flying bird. A flying bridge on either side of the wheelhouse gives the appearance of modified wings, and the low, tapering stern accentuates the illusion.

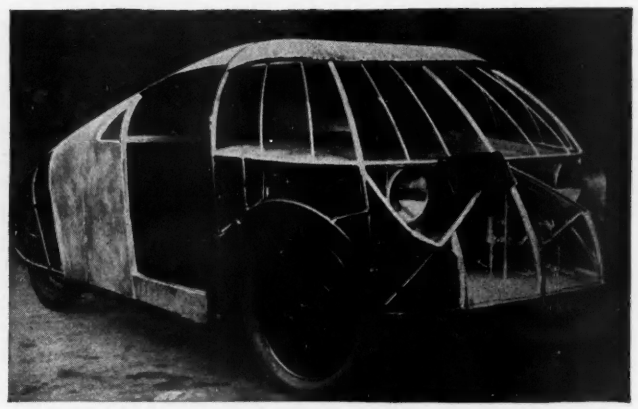
The *Kalakala* was built for the Puget Sound Navigation Company at the plant of the Lake Washington Ship Yards. She is 276 feet long, she has a beam of 55 feet 8 inches and a draft of 13 feet, and her capacity is 2000 passengers and 110 automobiles. She is 97¾ per cent steel—a construction almost as unusual as the appearance. Even the wheelhouse is nonmagnetic steel; previous wheelhouses have always been wood. The new construction is a big factor in the elimination of the fire hazard, and that hazard was given unusual consideration. The ship is equipped throughout with a new design of fire-fighting apparatus unlike anything used heretofore on shipboard.

The superstructure is completely welded by a special electric method which gives great strength and eliminates unsightly rivet heads and overlapping plates. Five tons of welding rod were used in the ship's construction.

The *Kalakala* is propelled by a Busch-Sulzer Diesel engine which develops 3000 horsepower at 230 r.p.m. The auxiliary generating unit is a 600-horsepower Busch-Sulzer Diesel engine direct connected to a General Electric generator rated 500 k.v.a. with a 10-kilowatt, chain-driven exciter. This generator furnishes power for the various engine-room auxiliaries, such as blowers, compressors, pumps, as well as for the galley and lights.

—G. E. Review.





LIGHT CAR

STREAMLINED travel is here to stay. Airplanes, trains, and boats are streamlined. In the last few years many streamlined and semi-streamlined automobiles have appeared on the road.

Inventors have turned out many of these bug-like vehicles —one of which may be the precursor of the stock automobile of ten years hence. The designers of these cars must keep two things in mind: they must make the car safe and at the same time economical to build and run. The result of one attempt to accomplish this is shown in the photograph.

The entire frame work is patterned after an airplane fuselage. It is fabricated by oxy-acetylene welding of chrome-molybdenum steel tubing. Thus, both in materials and method, strength, durability, and ease of forming an intricate shape were achieved. This framework will be covered with sheet metal when the car is finished.

Certain requirements of lightness and economy make the use of standard motocycle parts imperative. Wheel forks from a motorcycle are used for the front end. Independent wheel suspension is thus provided. Motorcycle wheels are used both front and rear. A two-cylinder motorcycle engine powers the vehicle.

The car has a top speed of 75 m.p.h. and is supposed to run 40 miles on a gallon of gasoline. The driver and passengers sit only about 20 inches from the ground. The car is relatively wide and low slung; instead of glass a non-breakable transparent material is used for windows all around. Hydraulic brakes are used. Thus are the elements of safety assured; it is non-capsizable, fireproof, has a low center of gravity, is easily stopped, and is provided with forced draft ventilation.

While this oxy-acetylene fabricated car is an experimental model, it will undoubtedly suggest many possibilities for economical, efficient, and safe transportation.

—Oxy-Acetyline Tips.

PRIVATE FLYING

THE Model 19L *Coupe* has been developed by the Curtiss-Wright Airplane Co. for the Bureau of Air Commerce in their program to obtain a plane to meet the demands of the private owner and average pilot. (See TECH ENGINEERING NEWS, January, 1936, page 141.) Before undertaking construction, extensive studies were made as to the problems associated with the requirements of these pilots, resulting in the choice of an all-metal, low-wing design modeled after the transport types. Their efforts culminated in the construction of the two-place cabin monoplane, which, powered by a ninety h.p. Lambert R-266 engine, shows a maximum speed of 131 m.p.h., a cruising speed of 115 m.p.h. at 5000 feet, a normal range of 580 miles, and a fuel consumption of 5.8 gal. per hour. With one person, the range of the plane is extended to 1150 miles.

The side-by-side cabin is equipped with dual controls, the column of which conventional in design and similar to modern transports, with the exception that it is used in an inverted position, allowing the spade-type aluminum alloy wheel to move directly fore and aft with no obstructions in the cockpit. Doors are large, one on either side giving access to either front seat, both of which are fitted with spring cushions and upholstered to suit individual customers.

Of all-metal monocoque construction throughout, the skin gauges are of 24ST alclad aluminum. Structure of the fuselage is of raised rings, stringers, and stressed. Wings are all-metal full cantilever type built up of five spars with the skin designed to carry the loads. There is a split flap on the trailing edge of the wing extending 70% of its span and operated by a rotating handle in the cockpit. A full monocoque landing gear with a 10 inch oleo stroke and jull air wheels is used. The engine is mounted on a steel tubular structure, and is supported with rubber bushings to absorb vibration.

—*Aero Digest.*

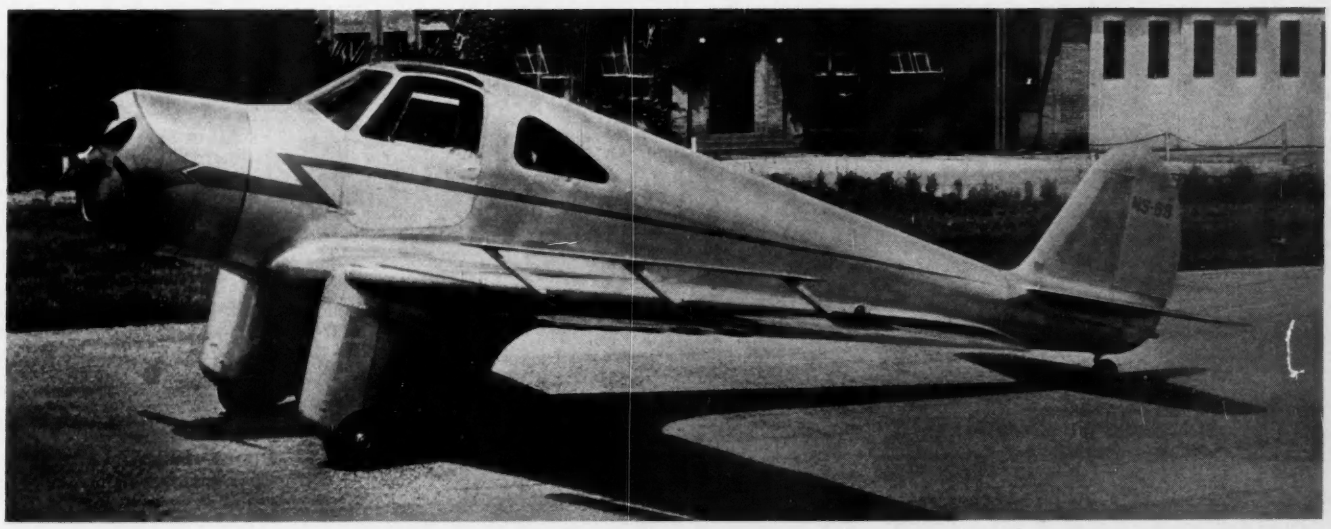
POLITE EXPLOSIONS

BECAUSE large pieces of coal—the so-called "premium" variety—are more valuable than small ones, and in order to escape the fumes which hamper work and sometimes endanger life, certain coal-mining areas in Illinois and Indiana have discarded dynamite blasting in favor of compressed air. With the new equipment the coal is "politely pushed" out of place by the air pressure.

The coal dust and chips which are broken out by the dynamite are difficult to handle and bring much lower prices on the market than the larger chunks. With the absence of fumes under the new method, miners can start loading coal immediately after the "shooting" and do not have to wait until the air clears. The mine level does not have to be vacated, as is the case when explosives are used.

With the new method a portable compressor stores air up to 15,000 pounds pressure in a long metal cartridge. The latter is inserted in a hole drilled in the face of the coal and a valve suddenly realeases the air, which, in expanding, pushes out the coal in big chunks. The steel cartridges are specially designed and may be used over again. The entire operation is conducted directly at the coal face, and cartridges are filled in 90 seconds. Miners and equipment retreat to a distance of 100 or 150 feet during the explosion.

—*G. E. Review.*



RESEARCH IN REVIEW

COURSE VIII — Physics

THERMIONIC emission from hot filaments, both of pure tungsten and of tungsten with coatings of oxide, thorium, and other materials, is a subject of great importance to the electrical engineers, but one which has been particularly investigated by the physicists. Professor Nottingham has been working for a number of years on emission in small accelerating and retarding fields. It is only with small fields that one can get information about the finer details of the emission process, such as the reflection coefficient of electrons as they emerge from the surface, or the effect of local irregularities in work function. Such experiments have previously been almost impossible on account of the potential gradient in the filament due to the heating current, as a result of which different parts of the filament were subjected to different external fields. Professor Nottingham has ingeniously overcome this difficulty by a device which alternately heats the filament for a small fraction of a second, then turns off the heating current and makes measurements before the filament can cool.

Another advance in the theory of thermionics has been made by Mr. R. P. Johnson, working under Professor Nottingham. Mr. Johnson is investigating the electron emission from a single crystal of tungsten using a cylindrical electric field and a fluorescent screen in such a way as to form a magnified image of the surface of the filament, with bright patches where most electrons are being emitted. In this way it has been found that the emission is not uniform over the whole crystal, but that certain crystal faces emit electrons more strongly than others. This discovery will have important applications in the theory of emission from polycrystalline tungsten.

With a view to thermionic applications, a theoretical calculation of the behavior of electrons in tungsten is being made by Drs. Manning and Millman, under the direction of Professor Slater. Using the differential analyzer, they are first calculating the electron orbits in the free atom of tungsten. Next they will find the change in these orbits when the atoms are combined into a crystal, by a newly devised theoretical method which has been applied to the alkali metals and copper. The result should be complete information about the ease with which electrons can travel in different directions through the tungsten crystal, and, by a later extension of the calculations, the emission from the surfaces in different directions can be studied theoretically.

COURSE XII — Geology

IN the field of mineralogy, effort has been concentrated on two research programs under the direction of Professor Buerger. One of these can be described as crystal polymorphism, and the other, the application of some new crystallographic theory to the study of the crystal structures of certain mineral groups.

Temperature, pressure and composition are the factors conditioning the state of an ordinary physico-chemical system. For a definite compound, the composition may be regarded as fixed, leaving only temperature and pressure to define the physical state. The occurrence of a single compound in two or more such physical states, known as polymorphism, is not only of crystallographic interest, but of genetic mineralogical interest as well, for the particular modification found in a given instance gives information as to the conditions under which the mineral deposit was formed. It now appears, however, that chemical compounds are not necessarily "definite compounds" in the strict Daltonian sense, but that, although tending toward a definite composition, they deviate from this ideal because of foreign atoms in the environment at the time of crystallization. It follows that the state of a "compound" is defined not only by its temperature and pressure, but also by its composition, that is, by the deviation of its actual composition from the ideal composition. It further follows that the state of a compound can be controlled not only by controlling its temperature and pressure, but also by controlling the chemical environment in which it crystallizes. It is this phase of polymorphism that is being studied in the Department of Geology. The crystallographic aspects of this research are being undertaken by Professor Buerger; Mr. M. C. Bloom is undertaking the very important chemical aspects of the research. The chemical side of the problem is very exacting for it appears that very minute changes in composition may shift the position of the inversion boundary between phases in both temperature and pressure directions. Encouraging results have been obtained with the two compounds Sb_20_3 and HgS. An intensive program is outlined for investigation, which includes the testing of the relative stabilities of the phases formed by a potentiometric method. It appears that the point of view being developed may give a more reasonable meaning to Ostwald's empirical rule for the anomolous appearance of so-called "unstable" phases.

Crystal structure analysis has two aspects; first, a purely geometrical aspect concerned with the determination of the general symmetry and repeat period of the three dimensional pattern governing the packing of atoms, and, second, the problem of determining the specific positions of the atoms once their pattern symmetry has been discovered. Ever since about 1912, the science of crystallography has been in the hands of physicists who have applied their customary purely analytical methods to the new X-ray crystallography. The analytical point of view is an unnatural one for the first, purely crystallographic aspect of the problem and has tended to obscure the meaning of some of the effects and therefore has permitted overlooking much of the crystallographic information obtainable by means of X-ray methods. It has been one of the programs of the Department to develop this phase of crystal structure analysis from a purely geometrical point of view with the end of developing the maximum general information obtainable from X-ray diffraction experiments. This has been applied to the moving film, the Weissenberg method of recording diffraction data. It can now be fairly said that the several purely crystallographic features of X-ray analysis are the most secure part of the crystal structure analysis argument. Furthermore, procedure has been reduced to such a simple geometrical basis that the X-ray films taken by the method developed can be interpreted by simple inspection to yield the required centrosymmetrical point-group, the space lattice type, and the space-group in time measurable in minutes. By the older, analytica methods, days or weeks were required to interpret the data. A special form of apparatus has also been developed which automatically puts the experimental record in a form in which symmetry and pattern type are invariant and which facilitates this inspective interpretation of the data. This geometrical method of obtaining crystal structure information has been applied to a number of minerals with excellent success, including the arsenopyrite group (FeAsS and FeSbS), valentinite (Sb_2O_3), cubanite ($CuFe_2S_3$) and berthierite ($FeSb_2S_4$).

COURSE VI Electrical Engineering

THE possibility of utilizing data obtained by electrical measurements on the human body, as an indicator of the pathological condition of the individual, has received continued attention since the publication of a note on this subject in the TECH ENGINEERING NEWS for December, 1934. Measurements of the electrical impedance continue to offer the most promise of showing significant correlations. In particular, the constant Q, the ratio of the reactance to the resistance, has been determined for an increased number of individuals. It has also been observed continuously, for a few individuals, over periods extending up to several hours. These careful, long-period observations have been planned so as to include any effects accompanying changes in the body resulting from pronounced exertion and from repose.

In this investigation measurements have been made of the internal tissues, as distinguished from the surface sheath. Apparatus by which the impedance of these internal tissues may be measured directly, at a frequency of 10 kilocycles, has been improved so that considerable accuracy may be obtained in the measurement of Q. Results are not yet sufficiently complete to permit the formulation of specific conclusions. The picture of general trends, however, shows promise of coming into focus. A number of details have appeared during the past year.

For a single healthy individual the constant Q, determined for the internal tissues as described above, between electrodes applied to the upper arms, may vary by 20% or more. The variations thus far observed appear to be definitely associated with fatigue or relaxation. A considerable change may, under certain circumstances, take place in a single hour. For a group of normal individuals Q may vary from 0.07 to 0.10. For pathological cases, however, a spread from 0.02 to 0.14 has already been encountered. These three statements, generalized from a large quantity of detailed data, suggest strongly that, once its significance has been established, a knowledge of the value of Q may aid materially in the diagnosis of physical disorders.

AIRLINES

(*Continued from page 164*)

orological staff of Eastern Air Lines invited the Massachusetts Institute of Technology to carry on another of its experiments in the important field of aeronautics at the Municipal Airport, Atlanta, Georgia. The Institute has set up thirty-five instruments which will be released during an active storm condition. They are particularly anxious to obtain a picture of the upper air during the passage of a tropical cyclone or hurricane. It is expected that the results of this experiment will be of direct value in anticipating the effects of a tropical storm along the Atlantic and Gulf Coasts of the United States. This is only one of the many experiments and researches in which one airline is taking part. Every transport company is making its own special tests, and the Bureau of Air Commerce is working steadily for the perfection of equipment and communications.

Nor is the comfort and well-being of the passengers being overlooked while this concentration on mechanical perfection goes on. Courteous and efficient service of the most superior kind is found in air transportation. All through the organization of an air transport company can be found courteous, wide-awake, dynamic, skilled men and women, competent in the execution of their tasks to which they have devoted many years of specialization. The personnel in ticket offices also are generally specially trained college men. The pilots, most of whom have flown over a million miles, were in the majority trained in the United States Army and Navy Schools, the most exacting in the world. They have flown all types of aircraft, day and night, in all weather, and are physically fit and mentally alert—trained men in the fullest sense of the word.

COLOR

(*Continued from page 161*)

detailed procedure. Suffice it to say that the calculations are of a sort that can be readily carried out by means of a modified form of adding machine. In Figure 4, a photograph is shown of a calculating machine of this type which has been constructed for attachment to the photoelectric spectrophotometer built for the Color Measurements Laboratory at the Institute. This spectrophotometer is entirely automatic in its operation and records a complete spectrophotometric curve in from two to four minutes. By attaching the calculating machine to the spectrophotometer, the necessary calculations can be made automatically as the gamut of spectrum colors is traversed.

A color specification in terms of brightness, dominant wavelength, and purity seems to provide the basis for a universal language of color that has hitherto been lacking. Until the possibility of a universal and fundamental language is suggested, it is difficult to realize the handicap caused by the lack of such a language. It does not strike one as incongruous, for example, that in purchasing almost any article of commerce the specification of all its important physical characteristics (such as size, weight, etc.) can be read and understood, whereas it is almost impossible to form even an approximate idea of the color without seeing a sample. Historians agree that man's progress was slow until he developed a language that enabled him to impart to others the experience that he had acquired. With an adequate and fundamental language of color available, we can begin to accumulate a vast body of color knowledge that otherwise is no more permanent than a sample of the color. The possibility of accumulating this body of color knowledge points definitely toward a "new deal for color."

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CANCER

(*Continued on page 158*)

had never been demonstrated to occur in the body, the suggested possibility caused many to transmute, by purely imaginative processes, the theory into a fact. The alchemists could have done no better. Immediately the theory of the hormonal origin of cancer arose and many workers in the field of hormones and vitamin D felt real concern for their safety. The evidence that any such degradation to an aromatic hydrocarbon occurs in the body is still lacking. More significant still is the fact that the product of the chemical degradation in the laboratory of bodies, constituted similarly to the hormones, has never been shown to be an agent for malignant growths. Only in the case of the bile acids has a series of such chemical degradations yielded a carcinogenic agent. It is questionable if these steps occur in the body. It is interesting to note that in examination of the mummies of ancient Egypt no evidence of cancer has been found. If deranged metabolism of naturally occurring products is the seat of the trouble, the cause or occurrence of this assumed derangement must be sought in our modern life. Although it does not now appear that the theory of the hormonal origin of cancer can be substantiated by facts, the speculation has been a great factor in stimulating discussion as to the fate of the naturally occurring compounds in the body.

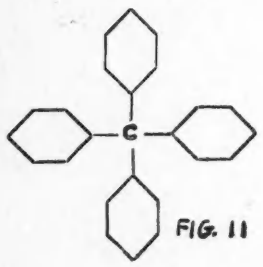

FIG. 11

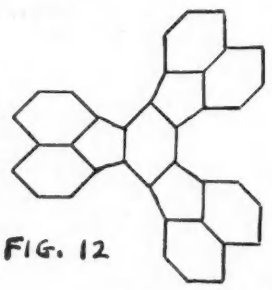

FIG. 12

Interest in this field at the Institute has not been lacking. A few years ago the author with Dr. Clapp, then a graduate student in organic chemistry, and Dr. Branch of the Evans Memorial Hospital in Boston, began experiments with an entirely new series of compounds. These studies arose from the belief that it was necessary to test the carcinogenic activity of compounds structurally unrelated to the known agents, yet chemically comparable in their reduced activity toward many chemical reagents. The results have confirmed the original supposition. Triphenylbenzene, tetraphenylmethane, and trinaphthalenebenzene (Figs. 10, 11, and 12 respectively) have all been found to be capable of inducing malignant growths. The activity of the first two is distinctly less than that of 1, 2, 5, 6-dibenzanthracene, but the higher members of these two series are under investigation and may prove to be more active agents. The potency of the last named compound cannot be judged accurately at present since all of the tests are not completed. The early results suggest that it is much more active than the first two. These experiments, as well as those with other types of compounds are being made in the hope that some basis may be found whereby carcinogenic activity can be predicted. With the ever increasing use of organic chemicals this is a problem of vital importance. Work is also in progress on the fate of carcinogenic agents when injected into the animal body, as well as on the behavior of some combative agents.

The method of testing these substances is time consuming. What would require years in a human being need only take weeks in the life of a mouse. Yet this time is very long indeed compared to routine chemical tests. The procedure is to paint at regular intervals the skins of a number of mice—at least ten and preferably more—with a solution of the compound in benzene or oil such as sesame or lard. Growths usually appear after an interval of three to twelve months. Methylcholanthrene, one of the fastest agents, produced tumors in 75 days. Another method is to inject the solution into the mouse at intervals of a week or more apart. It has recently been found by Dr. Shear of the Harvard Medical School that a single injection of crystals of cholanthrene subcutaneously in mice induced cancer by the 62nd day. All tumors are not malignant. A wart, for example, is a tumor, but no interpenetration with normal tissue occurs. Observation that a growth occurs is therefore not enough. Microscopic examination of sections must be made to observe if the tumor is penetrating into the normal tissue and if cell division is occurring. A further test is to transplant the tumor onto a new host. If it continues to grow, the malignant nature is unquestioned. At present these methods represent the only reliable way to decide the carcinogeneity of a compound. Fluorescent spectra has proved unreliable. Truly there is a great need for a rapid, yet accurate, method of testing. Work in this field would be enormously facilitated if such a tool were at hand.

Little is known as to why or how these substances produce cancer. Malignant tissue produces lactic acid faster than it can be oxidized. Hence it might be inferred that the hydrocarbons have an inhibitory effect on the enzyme, lactic dehydrogenase. Experiments with this enzyme have in fact shown that as a class an inhibitory action does take place. There are some glaring irregularities in the degree of inhibition, which cast some doubt on this theory. Another view is that the hydrocarbon acts as a chronic irritant. Against this opinion is the fact that no skin rash develops when the substance is applied. The full explanation must await the results of further research.

Besides the question of the mechanism of their action, many other interesting questions confront the organic chemist. For instance, why should the arrangement pictured in Figure 2 produce cancer while that in Figure 3 does not? In the former the two terminal groups are directed away from each other whereas in the latter they are faced in the same direction. How strange indeed that the shortening of the system by one ring produces the opposite effect! 3, 4-Benzphenanthrene, Figure 13, will readily induce cancer while its isomer, the 1, 2-compound, otherwise known as chrysene, shown in Figure 14 will barely function in that way. One naturally wonders what would happen if the system were lengthened instead of shortened by one ring. These and many other problems make this field particularly intriguing to the organic chemist. Although progress appears very fast, there is an enormous amount of territory to be surveyed and mapped.

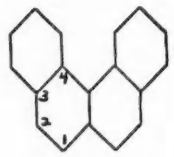

FIG. 13

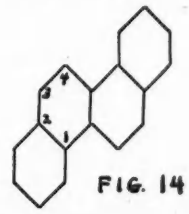

FIG. 14

The magnificent start given to the study of specific carcinogenic compounds by the workers at the Cancer Hospital (Free), Research Institute in London has been due to financial support of the British Empire Cancer Campaign aided by brilliant imagination and planning. Organized effort has not been lacking in other countries, but until recently much of the work has been along other lines. Already laboratories in leading universities and research institutes are directing attention to this new channel. It is safe to predict that this fresh impetus will lead us far in the direction of a solution of this most important problem.

RUTS OF STAGNATION

(*Continued from page 165*)

nize that the things they did and the ways they did them are worth working hard for and then work hard. Or, if you must stagnate, do it uncomplainingly.

Professor Morris, resting with geologic solidity on the canons of sound psychology, recommends a worth-while spree as a stagnation slayer—not the kind of spree that brings about hazy perception, dulled sensitivity, tortured talk, and sundry sinks of iniquity, but the kind of spree that gives one a new enthusiasm, a throbbing interlude breaking a deadly routine, genial communion with poetry, music, drama. An evening devoted to such poets as Kipling, Eric Mackay, Ernest Dowson, even Dorothy Parker; or the music of Schubert and Tschaikowsky, dripping with emotion, has its place in a world beset with the pitfalls of stagnation.

Get outside of yourself, away from yourself, free from yourself once in a while. Otherwise, like the family Leguminosae, because the peas were green and the pod was green, you will think the whole world is green.

"That's all very well," you say, yawning magnificently, "but I'm not afraid of stagnation." Oh ye of little perception; unless you feel a premonitory prick of panic at the very thought of stagnation, its sweet and soothing paralysis is already upon you.

To the man who ever keeps his nose to the monotonously revolving grindstone every moment is like every other moment and the ruts of stagnation have swallowed him already. For his own sake, as well as for the safety of the business, he ought to be fired. It may shake him out of his rut. To the man who is still vitally alive, sensitive to new truths, eager to see the other side of the mountains, only those inspired moments are worth counting in which there is the zest of new beginnings or the mile post—never the final goal—of new achievement.

Most men begin to stagnate, religiously for example, by the time they reach college. The process is pretty universal and complete before age forty. This is one good reason why men have to die. The old grey mare was plenty good enough for father, no automobiles for him. I drive my car 15,000 miles a year and lift an eyebrow at the airplane. Old *terra firma* is plenty good enough for me and the more firmer the less terror. But son Richard sighs for the joy stick and an ampler age when dad's stuttering explanations of why he should keep his feet on the ground will no longer be effective.

We reject the very need for change and have to die in order that a new generation may accomplish it. The faithful old employee who has been with the company so many years didn't get the promotion. "That's the heartless ingratitude of business for you," everybody declares with some asperity. Everybody? No, not those who realize how many years ago the faithful old employee became completely stagnant. To promote him would be suicide for the company.

You seniors are already looking around for jobs. Accept the best financial offer? Not on that basis alone if you are wise. What has happened to the 40-year olds in the company? Are they on the way up or on the way out? If the latter, don't accept that offer; the company buries its youngsters in the ruts of stagnation.

Go to work for dad? Not right out of college if you know your psychology. Dad brought you up in the fear of God; that is to say, what Dad thought was right, and he will complete the process by saddling you with most of his pet business ideas. Listen to the ominous drum-beat of threatening stagnation; go to work for dad's deadly rival; and after five years in the old factory go back home. Then you may be able to shake the old man out of *his* rut instead of letting him pull *you* in.

Remember that education is a system of habits for growth which must be a life-long process. When you stop growing, death, be it physical, mental, or spiritual,begins. "The only difference between a rut and a grave is in their dimensions."

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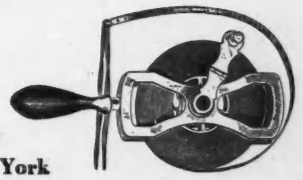

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"FROSTBITE" DINGHIES

(*Continued from page 176*)

Let us assume that we are relatively new to the sailing game. Let us assume also that we are located convenient to a suitable body of water; that we have prospects of plenty of friendly racing competition, also a suitable boat house or other housing facilities. Let us choose a sailing dinghy for our yachting fun. Of course we want to combine speed and nicety of construction with reasonable safety, therefore—if purchasing an existing boat—ascertain the standing of her designer and builder, also her racing reputation. Carefully examine the condition of her hull and gear. Satisfy yourself as to the age and condition of her sail or sails and their maker. If having a new boat built, select an experienced architect and responsible builder. Above all, do not be picayune as to cost. Remember, a boat, be she big or little is a "hand made" proposition and—for your proper enjoyment—should be a work of art. Therefore, insist upon the best and be willing to pay for it. This is the only way to secure the best sailing satisfaction. If time and facilities permit, by all means take entire care of your dinghy yourself. This is the only way to get the maximum enjoyment from your time and money spent for sailing. The sailboat, as if she were actually a thing of life, seems quickly to recognize and love her master. A skilful and congenial "crew" are essential to race your dinghy successfully. The person who sails with you, he (or she) should be of moderate weight (for live shifting ballast), say between 140 and 170 lbs., mentally alert to anticipate, and physically quick and strong to act; also of steady nerve and genial personality. The last in order to "take it" from a skipper at times irritable without talking back. You as skipper of your boat must carefully inform yourself as to the racing rules. Ignorance of these rules is no excuse and many an otherwise good race has been spoiled by a lack of knowledge of such rules by one or more of the contestants.

Before the start of your race make certain that your boat, in every little detail, is as ready as it is physically possible to prepare her. There is a common belief that consistently successful skippers win their race or races "the day before" by careful preparation of boat, gear, and sails.

In general there are four types of races.

(a) With only two contestants, known as a "match race." In this type of race you have only one competitor to watch, therefore never forget the cardinal rule: always, if possible, keep between him and your mark. If ahead of him and holding him, never let him leave you. Conversely, if behind him and losing, try to leave him and go "wind hunting." If he is wise he won't let you.

(b) With more than two contestants, known as "class" racing when confined to a single class, all sailing at "scratch," or as mixed class racing when two or more classes sail together with time allowance between classes. The strategy employed should be quite different than in (a): a case of every boat for herself.

(c) Team racing with two or more boats representing a club and two or more clubs represented, all starting at same time. Different strategy from both (a) and (b): combinations between boats of the same club to run opponents far off the course are unsatisfactory and not conducive to good ethics. Fortunately this system is rarely used today.

(d) Team racing by "change-about" of crews, a most satisfactory and commendable system. By this system a club is represented by one crew, with two or more club crews starting in each race: 3, 5, 7 or more races to determine the match. After each race all crews swap boats, thus: suppose we have crew representatives from clubs A, B, C, and D competing for a special event and using boats as nearly of equal speed as possible to obtain, and numbered say 1, 2, 3, and 4. For the first race we would have say crew A in boat 1, crew B in boat 2, crew C in boat 3, and crew D in boat 4. For the second race, crew A would be in boat 2, crew B in boat 3, crew C in boat 4, and crew D in boat 1, etc. until the match is finished. The total points decide the winning crew or club.

In all racing rights of way according to the rules must be rigorously observed by the skippers. When the rules are violated, the race committee should promptly give a decision and disqualify the offender before the next race is sailed. Laxity regarding this important point—on the part of skipper, or race committee, or both—is the most fertile source of misunderstandings in yacht racing.

The Royal Canadian Yacht Club of Toronto, Canada—a very progressive club and second only to the New York Yacht Club in membership and wealth on the Western Hemisphere—does not necessarily wait for "protests" from the contestants themselves, but "if it is brought to the attention of their race committee" in any way, this committee will at once call a hearing and give its decision. By this method ill feeling between contestants is largely avoided. While it is proper ethics and the rule in yacht racing for the able yachts to continue the race, leaving a disabled competitor to care for herself as best she can, in dinghy racing, the ethics and rule is for the nearest dinghy or dinghies at once to stand by and rescue a capsized competitor. Failure to do so means prompt disqualification of the neglectful dinghy. This is an excellent custom and in the interest of general safety.

At the conclusion of each race, and as soon as conveniently possible, after exchange of the customary courtesies between winner and loser, the skipper should make a careful examination of the gear and sails of his dinghy for possible defects or for improvements. Sails should be thoroughly dried before stowing away. The hull should be carefully wiped off with wet chamois and stowed under cover, awaiting the next race.

For the dinghy sailor there seems to be no such time as "when winter comes" because the dinghy enthusiast keeps up his sailing until his waters are actually iced over. Then he resails his past races by discussion and argument and plans for his future sailing joys. May his shadow never grow dim!

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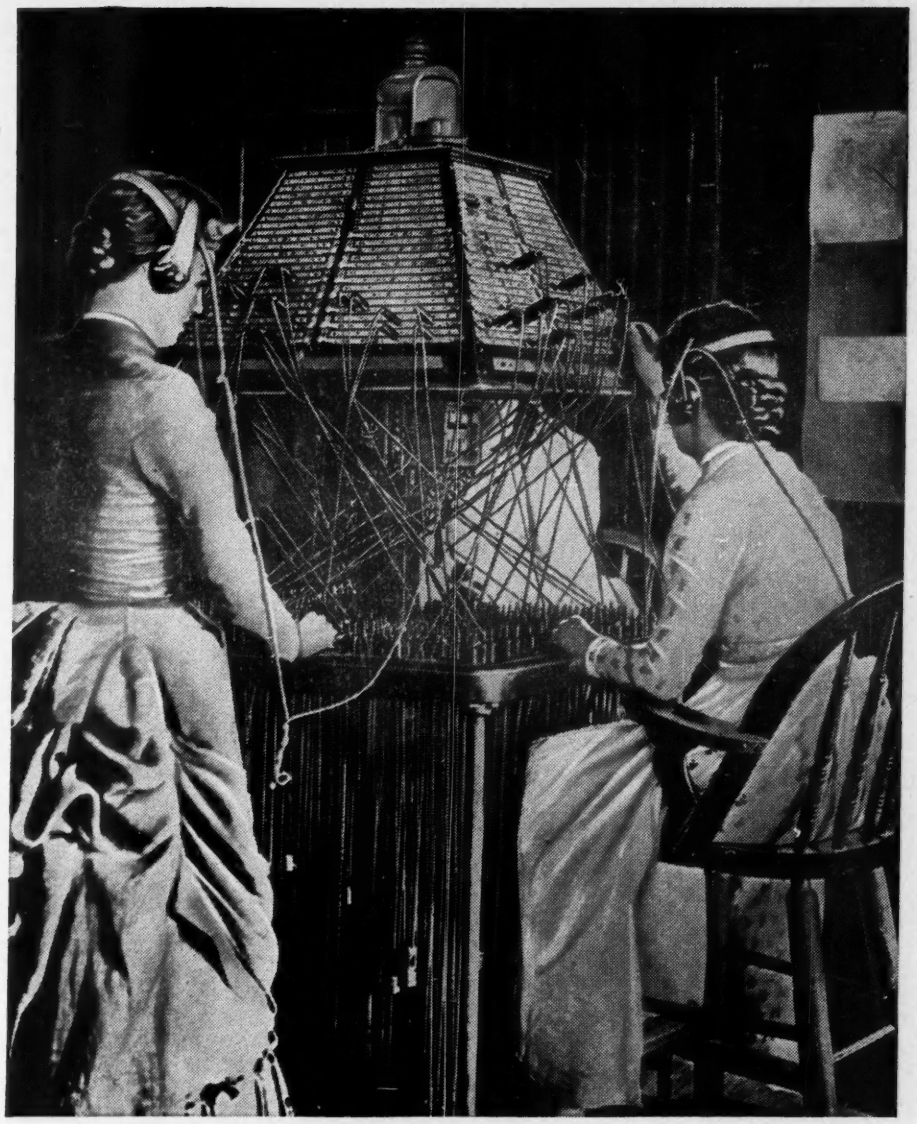


"Newfangled invention" makes good

"Can you really talk through a wire?" people still asked when this early telephone switchboard went into service in 1881. ¶ Apparatus was crude—service limited—but the *idea* was right. It took hold in spite of ridicule. Today there are more than 13,000,000 telephones in the Bell System—telephone conversations average 60,000,000 daily—the service is faster and clearer than ever. ¶ Telephone growth and improvement will go on. For Bell System men and women work constantly toward one goal: enabling you to talk to anyone, anywhere, anytime.

Why not call Mother and Dad tonight? For lowest rates, call by number after 7 P. M.

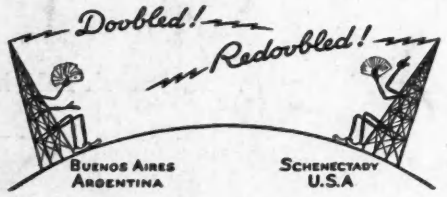
BELL TELEPHONE SYSTEM

G-E *Campus News*

CRASH!

IT'S a thunderstorm sweeping over Pittsfield, Massachusetts. But G-E engineers, instead of hiding under the bed, go up on the roof to be nearer the lightning. On one of the buildings of the Pittsfield Works they have built and equipped a lightning observatory. By means of an ingenious periscope and a high-speed, motor-driven camera, any lightning flash occurring within many miles—north, south, east, or west—can be automatically photographed. Its characteristics, as recorded on the film, can then be compared with those of the artificial flashes produced by the 10,000,000-volt lightning generator in the laboratory.

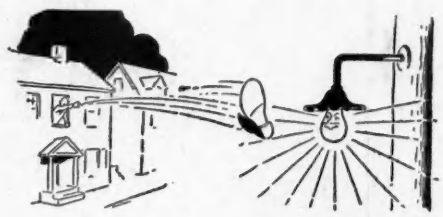
An observatory has to have a hole in the roof. This causes astronomers no embarrassment, because they can work only in clear weather. But with lightning observers it is different—when there is lightning there is also rain. So, to keep the rain from falling on the 12 lenses of the new camera—and from running down the engineers' necks—compressed air is blown upward through the aperture. When next the thunder rolls over the Berkshires, and timid citizens are cowering under the bedclothes, these General Electric engineers will be up on the roof taking elaborate notes on Jove's own brand of lightning.



GAME BID

DOUBLED! Redoubled! North led, but the dummy was 6000 miles away. Psychic bids flew thick and fast when a North American contract-bridge team, including Mr. and Mrs. Ely Culbertson, played a "bridgecast" tournament with a high-ranking team from Argentina. The North Americans were seated on the stage of Rice Hall in the General Electric Company, at Schenectady, N. Y., while the Argentine team played at the Casabal Club in Buenos Aires. The plays were carried by the short-wave stations W2XAF and LSX, of North and South America, respectively.

W2XAF, in Schenectady, used a feed-back circuit so that short-wave listeners all over the world, tuned to the one station, could follow the playing with as great ease as the 500 kibitzers who jammed Rice Hall. This was the first international bridge broadcast in which the principals were all recognized experts. The North American team, captained by Culbertson, won by a margin of 1030 points.



BEDROOM PRIVACY

MANY a man has shinned up a lamppost to daub paint on a street lamp that shone in his bedroom window. Many another light sleeper, of lesser climbing prowess, has tried throwing shoes and hair brushes at the offending light. Now there is hope that this war will soon be over.

Adequate street lighting is, of course, a necessity. G-E illumination engineers have perfected a new fixture that directs the light where it is needed—on the street—and keeps it from trespassing on the pillow. A concealed light source and a reflector designed along new optical lines have removed street lamps from the list of public enemies of sleep. Motorists, too, will welcome these new luminaires. Because the reflector extends below the incandescent source, the driver's eyes are protected from direct glare—he can see the road better.

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